LECTURES ON SCHOOL HYGIENE

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Massachusetts Emergency and Hygiene Association.

SIX LECTURES

UPON

SCHOOL HYGIENE,

DELIVERED UNDER THE AUSPICES OF THE

Massachusetts Emergency and Hygiene Association

TO

TEACHERS IN THE PUBLIC SCHOOLS.

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SCHOOL HYGIENE:

ITS RELATIONS TO THE MASS. EMERGENCY AND HYGIENE ASSOCIATION.

An Address delivered before the Mass. Teachers' Association, at its Annual Meeting in December, 1884.

By FRANK WELLS, M.D.,

Vice-President of the Mass. Emergency and Hygiene Association.

Allow me, before I enter upon the subject-matter of this lecture, to thank you for the privilege, I enjoy to-day, of addressing you upon a topic which to all, whether directly interested in the education of the young or not, must be one of vital importance, — viz., school hygiene, — and of laying before you the relations which the newly-formed Emergency and Hygiene Association bears to it. This privilege I esteem the greater, since in no more practical way can the question of school hygiene obtain for itself a more widely-spread consideration, than through a body which exerts such a powerful influence as the teachers of Massachusetts. To you, teachers, are entrusted the care of thousands of children of all ages through the greater portion of the working hours of the day, and upon you therefore rests some of the responsibility, at least, of forming healthy bodies as well as healthy minds. Hence any assistance which can be rendered to you by those who have made a study of school sanitation, must be looked upon by them as a privileged duty; and with this thought I now invite

you to a consideration of the various details of the subject, which I trust may not prove wholly uninteresting to you.

To more thoroughly understand the relations which the Emergency and Hygiene Association bears to school sanitation, it will be necessary, in the first place, to briefly refer to the origin of this Society and to the scope of its work. In 1883 the Woman's Education Association, to which body this community is indebted for several very important reforms, recognizing the necessity for diffusing useful and practical knowledge among the masses, to be used in cases of accident or sudden sickness, undertook to provide such instruction, by volunteer lectures to both men and women, as would accomplish this result. Seven courses of lectures to free classes and three to paying classes were given during the first year with such success, that the Association was encouraged to increase the number of courses in the following year to twenty-five. Of this number, eight were given to the police force, and two to the members of the fire department. These lectures simply gave instruction as to what should be done in cases of emergency, before the arrival of the physician or surgeon, with only enough theory added to render the practice intelligible. While the work of the winter was progressing, the advisory board, which had been formed of gentlemen representing various callings, was gradually enlarged; and when it became evident that the field of labor had outgrown the limits imposed by the rules of the Woman's Association, it was deemed fitting that the responsibilities should be assumed by a new organization. Consequently the Association now

known as the Massachusetts Emergency and Hygiene Association was formed, the work of which it was deemed very desirable should be extended throughout the State, and be made to include instruction in an increased number of branches of useful knowledge. A transfer of its duties was then made to the new Society by the originators of the first scheme, and various committees were appointed to take charge of the details incident to the various departments. These departments provide for the extension of the work throughout the Commonwealth, by encouraging the formation of branch associations; for the instruction of the better classes, who are able to pay a fee; for courses of lectures to be delivered to railroad employés, mill operatives, stevedores, and the like; to the members of the police and fire departments; to the militia; to missions and institutions; and upon school hygiene, to teachers, pupils in the normal schools and such others as may be interested in this subject.

This latter branch of the work was thought to be one of great importance, and one which, taking into consideration the standing of those to whom the lectures would be particularly addressed, — viz., the teachers in the public schools, — might prove to be far-reaching in its usefulness. To many of you the subject of school hygiene may be, and undoubtedly is, familiar, while to others it may never have been presented in its proper light; but to all, we have a hope that whatever instruction we may be able to give may be of some use, not only to yourselves directly, but also through you to the many children who are entrusted to your care.

Why is this work so important and so necessary?

Simply because hygienic abuses exist, and hence reforms are needed; because a large number of children die every year from contagious diseases, which have been unrestrainedly disseminated by the public schools; because some schoolhouses are badly located; many have serious imperfections in their systems of ventilation and heating, with overcrowding in the class rooms and in the recitation rooms, and with poor drainage and an impure water supply. Because, moreover, owing to poor light improperly directed, and to a close application to study under improper regulations, near-sightedness is found to be progressively increasing, in a direct proportion to the advance of the pupils into higher grades; and finally, because the high-pressure system of study of the present day leads to a breaking down of the nervous forces, to consumption, and to certain other diseases, which physicians are constantly called upon to treat.

That this picture has not been too highly colored, that these defects do actually exist, will become evident to all who enter many schoolhouses during study hours. Greeted by odors, which are sometimes so aggravated that they become wellnigh unbearable, in a temperature altogether too high, the visitor will be struck with the pallor and evident lassitude of certain scholars, who are vainly endeavoring to accomplish their allotted tasks; he will notice that some are sitting directly facing the light, and, bending their bodies in a constrained position, are studying or writing with their books held but a few inches from their eyes; he will see some pupils not recovered, but simply in a state of convalescence, from diseases from which they have been suffering; and

he will see others with flushed faces and further symptoms, indicative of affections from which they are about to suffer. He will recognize all this, and oftentimes much more, if he makes a thorough inspection of the building and the premises.

These, then, are the causes which have lead sanitarians to devote so much of their best thought to the hygiene of schools, and it is to these causes that I propose briefly to allude.

Situation. — In consideration of the well-known fact that children are highly susceptible to morbid influences, it is very essential that the schoolhouse, in which they pass so much of their time, should be hygienically located and built. Consequently, it should never be located near unwholesome nor noisy trades and industries. Above all, it should be so placed that each room should receive as much sunlight as possible, particularly in our northern climate. I say as possible, since in many cities the streets are so laid out that this desideratum is difficult of accomplishment. Architectural effects, which the æsthetic demands of our times seem to call for to an unwarrantable degree, should always be made subordinate to the principle of abundant sunlight, and consequently should never be allowed to interfere with a sufficient number of large, serviceable windows.

As dampness — conducing as it does to rheumatism, catarrh, and consumption, and contributing to the production of other affections — is dangerous to health, care should be taken that the schoolhouse is placed upon a dry soil (this applies of course more to the country districts), in a locality apart from swamps, ponds, and excessive tree growth.

Its cellars should be made impervious to dampness by concrete or asphalt floors and cemented walls. The condition of the cellar is one of great importance, for often it proves to be the source from which disease suddenly breaks forth. Often dark, as frequently damp, furnished with water-closets, and serving as a receptacle for all kinds of rubbish, and as a place in which to hang the outer garments, its vitiated air being frequently forced, by pressure from without in cold weather, into the upper rooms, the cellar proves to be a very efficient factor in the production of severe illness.

Ventilation and Heating. — In discussing this subject, I start with the broad assertion that there is scarcely a schoolhouse anywhere, in which the ventilation is sufficient for protecting the health of the scholars, nor in which the system is properly designed. This is certainly criminal, and those who are responsible for this grave sanitary defect should be held accountable for the injury to health which invariably ensues from it. Every one can understand that it is unpleasant to enter an illy ventilated apartment, and that, after a few minutes, headache, nausea, and lassitude may result from the vitiated air. But there are very few who realize that great debility and impaired digestion; that severe colds, consumption, and other diseases of the respiratory organs may be caused, and "the development of glandular enlargement and scrofula, in their more severe forms, favored by confinement in the foul atmosphere of an unventilated room." The importance of good ventilation cannot be too deeply considered, and the best means for providing it must always receive the attention of sanitary bodies. The idea uppermost in

the minds of many persons — I will not say educated persons, although a visit to some of the schoolhouses might convince a person contrariwise — the idea prominent with many is that, to secure good ventilation, it is only necessary to open a window. This surely admits a copious supply of air, but it provides no method for the passage outwards of the foul air, which is one of the very essentials of good ventilation. That is, perfect ventilation consists, not only in the admission of pure air, but in the drawing out of that which has become vitiated. It aims primarily in getting rid of that odor which is as characteristic of the school-room, as that of the hospital is to it. In banishing this a great gain is made, for a sense of freshness in the atmosphere indicates its actual purity. Much can be accomplished in this direction by a judicious supervision on the part of the teacher, by insisting upon the personal cleanliness of the pupils. I think that valuable assistance is being rendered in this particular, in our large cities, by those charitable organizations, which by domiciliary visits inculcate, among other things, the principles of health in the families which they have under their charge. Over-garments should never be hung in the school-room, nor in any place in a dark, unventilated closet or wardrobe; since reeking as they often are with the odors of cooking, and bearing, it may be, something more injurious still, such receptacles condense the effluvia, and tend to the concentration of what may be the germs of disease. If the clothes are hung in the basement, care should be taken that it is not in a position, from which the odors from them may be carried upstairs by the furnace pipes. This may seem to you a small matter

upon which to dwell; but when I tell you that in one of the most expensive schoolhouses built in this city, no provision was found to have been made for the care of the outer garments, and when you reflect that, under the combined influence of dampness, darkness, and non-ventilation, disease germs live and have their being, you will agree with me that this apparently simple question becomes an important one.

The first problem to be considered is that of fresh air. To solve this problem many theories have been advanced and many plans devised, a discussion of which does not properly come within the province of this address. I wish, however, to present to you a few general propositions, in order that you may fully comprehend what it is desirable to accomplish.

First, what is meant by fresh air? It is air in which there is no perceptible odor, which is not overheated, which is not introduced through a channel of communication, such as the cold-air box of the furnace, commencing in the neighborhood of cesspools or of decaying material of any kind, or which originates in the cellar; and, finally, it is air which is not too infrequently renewed, nor that of an overcrowded nor unclean room.

I have said that fresh air is not overheated air. Now, overheating is one of the great hygienic evils so frequently met with in the school-room,—an evil, because it is very potent in the causation of colds, and, moreover, leads to an over-stimulation of the circulation in the brain and nervous centres, thereby producing defective vision, headaches, and nervous irritability and depression. What constitutes overheating it is somewhat difficult to determine. One thing, however, is very cer-

tain, and that is, that the degree of heat should never be regulated by the feelings of the teachers, among whom so many individual idiosyncrasies exist, nor by the toleration of it which long habituation always produces. Therefore, there should be a standard, which standard is variously estimated. Morin says 59°, Ficker, 64°, and Varrentrapp, $65\frac{3}{4}$° F. Americans, as a rule, demand a higher temperature than the Europeans, and consequently a proper standard for them is estimated at between 65° and 68° F., which should in no case in the school-room be increased above 70°. If at this temperature there is a feeling of cold, it is because the circulation of the blood is not active enough, the pupils being confined too long at their tasks without exercise. You cannot make them warm by raising the temperature, or, if you succeed in so doing, it will be at the expense of headaches and still greater debility. Trust, then, to the thermometer rather than to your own feelings, and remember that the time to correct bad habits in this direction is at the commencement of the term, when the pupils return to school with their systems invigorated by their vacations. For if the children, as well as the teachers, become accustomed to an elevated temperature, a preference for it is generated, which is very difficult to eradicate.

There is one more point upon which I cannot forbear speaking before leaving this part of the subject, and that is the erroneous practice of lowering the windows at the top in order to reduce the temperature, thereby admitting a current of cold air upon the heads of the children. This sudden change of temperature is a prolific cause of colds, bronchial affections, or more serious

pulmonary difficulties, as may be easily believed when it is considered that, in the short period of three-quarters of an hour, this procedure has been known to lower the mercury in the thermometer 16° F. at the desk level.

Allusion has been made to overcrowding as a cause of a vitiated atmosphere. What constitutes overcrowding, however, is variously estimated, — the standard requirements as to area, according to the different observers, ranging from 300 cubic feet of space for each scholar, to the altogether too small a provision of 70 to 100 cubic feet, according to ages. Taking into consideration, however, economy of space and other problems of construction, the best authorities in this country express a preference for 250 cubic feet, which would necessitate a room 25 feet by 30, and 13½ feet high, to be occupied by forty scholars. Unfortunately, though, we do not often find less than fifty scholars assigned to one room, which reduces the space for each to 200 cubic feet. Still it is a matter for congratulation that there is a growing tendency to improvement in this particular. Certainly, upon looking back to my own school life in the Boston public schools, thirty years ago, I am rejoiced to see that some of the mistakes of overcrowding made in those days have been corrected, although there still remains a great room for additional improvement.

Having now discussed briefly what fresh air is, or rather what it is not, it remains for us to consider how to admit it into a room and in what quantities, and how to get the bad air out, — in other words, to study for a few minutes the real theory of ventilation.

First, the quantity required. This amounts to as

much as will reduce impure air to a standard of relative purity. It was formerly considered that carbonic acid was a specifically poisonous gas, but now chemistry teaches us that it is only dangerous by its interference with respiration. But the presence of carbonic acid gas in a room is an indication of the existence also of other gases and bodies which are injurious to health, and as the amount of the former bears a tolerably accurate relation to that of the latter, we have come to look upon its chemical determination in the air as an indication of its impurity. But all good air contains about four parts of carbonic acid gas to 10,000, which amount may be slightly increased by the admixture of human breath, without rendering it close and offensive. Practically each person vitiates 3,500 cubic feet of air in an hour, and hence this amount must be drawn out in the same length of time, and its place supplied by an equal quantity of pure air. This is equivalent in round numbers to 60 cubic feet per minute for each person, which is the standard requirement, according to Dr. Lincoln, for houses permanently occupied. For those, however, — and such are schoolhouses, — which are occupied at intervals and thoroughly aired in the meanwhile, 30 cubic feet per minute is sufficient.

It is not asserted that a standard which falls slightly below this would be dangerous to health, but if a much smaller allowance should be provided, as in the case of some schoolhouses, then evil results would be sure to follow.

The next question to be discussed is how the impure air shall be removed. In our climate the only efficient way (I exclude open fires as not practical in the school-

room) is by means of flues, properly constructed and judiciously managed. Unfortunately this is not always the case; in fact, I may almost say it is seldom the case. Go into certain school-rooms, and, against the evidence of your sense of smell, you may be told that the ventilation must be good, because, forsooth, there is a ventilating flue. True, there may be one, but just as truly it may be as worthless for its intended purposes as though it never existed, — nay, more so, for, unless it is so constructed that it will create a current upward through it of warm air, it can easily serve as a channel downward for a stream of cold air.

A flue, to fulfil its mission, must draw well, and in order that it should do this, it must be as straight and as vertical as possible. It must be smooth, continuous, and opening upwards out of doors; above all, warm — at least warmer than the outside air — since otherwise the current will be inverted; protected in cold places, so that it shall not lose its heat; and not located in the outer wall.

With such a flue (one for each room), having its opening large enough, and, on account of the sources of impurity being more frequently found at the lower levels, situated near the floor, the first problem of good ventilation will have been solved. The second problem remains to be considered, viz., the methods of introducing pure air to replace the bad air which has been aspirated by the ventilating shaft. The usual method of accomplishing this is by means of the cold-air box of the furnace, the furnace being the common means employed for heating, although some prefer the steam coil, which furnishes heat by direct radiation. But the

great objection to this method is that it does not provide a proper amount of fresh air, unless arranged in a manner presently to be described. A furnace is likewise open to the same objection, since it is very apt to be over-driven, thereby furnishing a quantity of hot air and carrying up the direct products of combustion into the rooms. If care, however, is taken in the construction and in the management of a furnace, so that its channels of inlet and discharge are large enough to give out a proper volume of warm but not hot air, the above objection will be removed. In other words, if it is remembered that a furnace requires brains as well as fuel to run it, it will always prove an efficient method for supplying one factor of a proper ventilation.

Where stoves are used, they should always be guarded by a metal screen, or jacket, as it is technically called, as a protection against heat, and for the additional purpose of ventilation. These screens should be considerably wider than the stove, which they completely encircle, extending above it a short distance, and either fastened to the floor or, as some prefer, reaching only as far as the bottom of the stove and there fastened, or partially encircling it, leaving its door exposed. A shaft is lead through the outer wall of the house directly under the stove, through which fresh air enters, and, being brought into close proximity with the stove by the screen, passes upward *warmed*, thus fulfilling one of the requirements of good ventilation. If the stove is placed near a window, the screen can be made to enclose it on all sides, excepting that towards the window, which, being opened, supplies the air to be warmed by the stove, before passing upwards in the general current. This is a very

simple and cheap method of introducing fresh air into a room, and one for which I am indebted to a late Report of the Michigan Board of Health. This same system may be applied to the steam coils, thereby relieving them of the objections which have already been mentioned, although there still remains the difficulty of regulating the heat, furnished by them, in warm weather.

No matter what system of heating is used, however, whether it is the steam coils, furnaces, or stoves, it is of vital importance, as has already been intimated, that the air supply should be derived from pure sources. Great carelessness is shown in regard to this, and too often impure air — air loaded with malarial poison, which settles to the lower atmospheric levels, or with the products of decomposition — is taken in through the shafts, thereby causing severe sickness, and more than defeating the objects for which these shafts were constructed.

No system of flues, however constructed, can do away with the necessity of thoroughly airing the rooms, by opening the windows at regular intervals. The thirty cubic feet of fresh air per minute for each scholar, which has been mentioned as a sufficient supply for rooms occupied for short periods, will not keep their atmosphere pure for an unbroken session of two or three hours. Hence it becomes necessary to open the windows occasionally for a few minutes (once an hour is none too often in average weather), while the scholars are kept warm by gentle exercise. The recess should be utilized for the same purpose, while the rooms should receive a thorough airing after each session.

Perhaps one of the most, if not the most, efficient

method of procuring a free admission of good air is the window-board, which is undoubtedly familiar to you all. By this arrangement the air current is directed upward, and has a chance to become heated before it descends to the lower levels. A wider board, placed one or two inches from the sash, may be used in the milder weather of the spring or autumn.

There is one more point to which reference should be made in this connection, and that is the faulty construction of schoolhouses, which provides for, it may be, sufficiently large and well-ventilated class rooms, but arranges recitation rooms totally deficient in even decent ventilation. Into these rooms, which are generally small, are crowded a much larger number of pupils than can obtain the proper amount of fresh air, and in this vitiated atmosphere they are obliged to remain, without relief, until the recitation hour is over. Economy of money and of space is not always an economy of health; hence such mistakes as these should be carefully avoided.

Drainage. — This subject is so vast and important, that but little more than an allusion to it can be made in this address. A good system of drainage is one of the greatest scientific advances of modern times; a poor one worse than none. For perfect drainage carries off efficiently and quickly, before decomposition has commenced, sewage which was formerly conserved in close proximity to dwellings. An imperfect system, on the other hand, furnishes channels of direct communication between the interior of our houses and the filth of the sewers, through which, sewer-gas, that composite emanation from decomposition, enters to undermine the health of the inmates. But the term sewer-gas, in its sanitary

sense, is not confined to the products of the sewers alone, but it includes, according to Waring, the emanations from waste matters undergoing decomposition in the absence of light and air, and in the presence of water, whether in a sewer, house drain, cesspool, privy vault, a compost heap, or in a wet, unventilated cellar. In cities and towns which have a system of drainage, this gas is found, of course, more frequently in the sewers and drains. Children, as has been said before, on account of their more delicate organizations, are more susceptible to morbid influences than are adults. Hence our first care should be that the drainage of the schoolhouses — and by this term is meant the disposition of all decomposable material — should be as perfect as possible. How often is this not the case; how often do we find schoolhouses — happily growing less in number — provided with imperfect methods of ventilating the drains, and some with sole dependence on those unreliable agents when used alone, — traps.

With certain defects in the drainage of schoolhouses, and particularly of the older ones in the larger cities and towns of the State, we are immeasurably better off in this respect than are those who live in the smaller places. For in the cities are enjoyed the privilege of health boards, and a ready access to the literature and to lectures upon the subject to enable us to rectify the evils. But in the country districts the case is different, and it is this latter consideration which, up to the present time, has been too long neglected. There are schoolhouses in the smaller communities throughout the State, which in the matter of hygiene are a disgrace to civilization; in which filth actually runs riot; with dirty floors,

uncleaned stairs, and disgusting privies; and from which consequently typhoid fever, as well as the other so-called filth diseases, may originate.

In this connection I desire to say one word in regard to an unsuspected cause of disease, which never, I believe, has been thoroughly discussed. I refer to the wells of schoolhouses, situated in remote country districts, and only used during the school terms. During the vacations no water is taken from them, and hence it becomes stagnant. In the autumn, when the term commences, the water in this condition is drunk by the scholars, thereby, either alone or in connection with the unsanitary condition of the surroundings, tending to produce sickness, which may be wrongly attributed to the houses in which the children dwell. It is a satisfaction to know that these matters are receiving due attention from the State Board of Health, to which Board we are indebted for many wise sanitary reforms.

Privies, as commonly constructed, are abominations, since they are exceedingly dangerous to the health of the children. In many country schools they are seldom cleaned out, and hence render the atmosphere impure, and become dangerous to the water supply. They should never be placed, when avoidable, in the same building as that which contains the school-rooms. If necessity compels their location in the cellar, care should be taken that they are placed in an apartment remote from the furnace, and one which is well ventilated by means of windows opening to the outer air. No matter where they are situated, however, they must be frequently cleaned out and thoroughly disinfected, in which case they are reduced to their minimum of danger.

Eyes.— As well recognized as it is that sanitary errors are productive of ill health, it is not so well known as it should be, that during school life defects in vision, particularly that form known as myopia or short sight, are progressive, and are produced by the same hygienic short comings. It is said that savage tribes are not short-sighted, and this as a rule is true of a child when he commences his education. But as the child is advanced from class to class, it is found in various parts of the world, such as Germany, Russia, France, Switzerland, and the United States, that abnormal vision correspondingly increases. This evil has not as yet become so pronounced, however, in this country, since more care is taken with the length of the study hours, and with those devoted to exercise and recreation. But even in America, the fact of increasing near-sightedness is so striking, that it is incumbent upon us to seek the causes in order that they may be removed. Young children, who are near-sighted, are undoubtedly so through inheritance, for the affection is, according to the best authorities, transmissible. In the case, however, of those who commence school life with normal vision, and become short-sighted afterward, a number of conditions, all relating to the hygiene of schools, contribute to the result. For one cause, we have poor light, or light improperly directed. Cohn states that the rate of near-sightedness increases in proportion to the poorness of the light, and the narrowness of the street in which the schoolhouse stands. The light should never come from directly in front; blackboards should not be placed between two windows, nor in close proximity to one. The best light is that which

comes over the left shoulder. Other causes are found in a bad position of the body, overheated rooms, imperfect ventilation, wet feet, indigestion, peculiarities of diet, excessive length or severity of study without relaxation, and lack of out-door exercise, all which evils are, according to Dr. Loring, "provocative of a certain laxity of tissue and want of resistance in the investing membranes, which finds its expression in the eye in a distension, which is in fact myopia." The remedy for this evil is suggested by a knowledge of the conditions which produce it. This knowledge alone should cause us to seriously consider whether, at the present day, there is not too much pressure of study, under unfavorable conditions, being forced upon school children, particularly between the ages of ten and fifteen, which is the great period of life for the development of short-sightedness, a period, too, when the body is developing most rapidly. That we as a nation shall ever be reduced to the myopic condition of the Germans, I do not believe; and yet the statistics of the affection in America should give us abundant food for reflection, in order that we may cry a timely halt to its onward march.

Omitting from lack of time a consideration of the subject of school desks and seats, and also that relating to the spread of contagious diseases by the schools, the foregoing reference to over-pressure leads us naturally to the discussion of the last topic of this lecture, — a topic which has become one of vital importance, involving, as it does, not only the well-being of the child, but also indirectly that of the nation. I refer to the intelligent care of the *nervous system.*

Dr. D. F. Lincoln has said, very truly, that to a child in good health nothing is more delightful than the properly directed use of his mental faculties. Properly directed, I emphasize, for unless the methods of study are so regulated, that the mind is not forced to assume a task before it has been sufficiently well developed to grasp and comprehend it; unless its action is spontaneous and not forced, the child partakes of its mental food with no appetite for it, a mental dyspepsia is produced, the bodily health suffers — the system is a bad one. As a rule, I think that a child in this country is forced beyond its physical capabilities and its development. This is particularly true in the case of nervous children (I use the common term), of which class there is unfortunately too large a number in the New England States. The charge brought against our American system of education, viz., that we endeavor to accomplish too much within a given period; that we impose upon the child too many subjects of study at one and the same time, is a just one. This fact was recognized some years ago in the Harvard Medical School, and the change, which was consequently inaugurated, has resulted in a more thorough education, and in more healthy minds to pursue its advantages.

Physicians are called upon every day to treat young women, who have been sacrificed to the American fetich of overwork. This is not entirely the fault of school-boards, nor of school-teachers; the blame must often rest with the scholars themselves, who, in their anxious desire to push forward, in their eager haste to be out in the world "doing something," as the expression is, overtax and overstimulate their brains, and

come to realize too late that *festina lente* is as truly applicable to the brain as to the body. Do any of you realize what the statistics of mortality from brain disorders are in this Commonwealth? Pray listen to them, for they are highly instructive. I quote from the forty-second Registration Report of the State of Massachusetts, which records that 3,562 deaths occurred from disorders of the brain in 1883, as compared with 1,386 in 1860. In other words, during this period, the mortality made the astonishing advance of 156.9 per cent, as against an estimated increase in the population of 61.2 per cent. Over the year 1882, the advance equals 4.9 per cent, while the population is estimated to have increased 2.2 per cent. In the period of twenty-four years, of which mention has just been made, apoplexy advanced 229.4 per cent in its mortality, paralysis 162.6 per cent, and insanity 157.7 per cent. Moreover, there seems to have been an increasing fatality from brain disorders in the period of life under forty.

As frightful as the contemplation of these statistics is, more serious still is the realization of the fact, which a careful study of the subject for many years obliges me to affirm, that the cause of this advancing mortality must be sought, not entirely in the worries and cares of adult life, but to a certain extent in the schools, in the ignorance of the needs of the nervous system so commonly to be found there. Arriving independently at this conclusion some time since, I am glad to be now supported in it by such a keen observer as Dr. Crichton Browne of London. This writer in a recent report upon over-pressure in the English schools says, that the great increase in suicide has been coincident in time

with the modern extension of education, and as being most prevalent in regions where the education is most widely spread. Besides this evil, he alludes to the fact that hydrocephalus and cephalitis — both brain disorders — have become relatively more common within the last twenty-four years, during the school age, and that somnambulism and somniloquency exist in considerable proportion, and are more or less associated with school work.

These disastrous results are reached partly by overwork, which is defined as an absolute excess of mental exertion, and partly by strain, or work at times of fatigue or under an unusual excitement. The one great mistake, which to a physician's mind is made, consists in prescribing, particularly in the advanced classes, courses of study which require too many of the child's waking moments to accomplish. Just how many hours a day a child should study is very difficult to fix by any general law. The most intelligent writers upon the subject give it as their decided opinion, that under the age of twelve, four hours of daily study are all-sufficient; below ten years, three or three and one-half, and below seven years, two and one-half to three hours. At no age, however, should the time required for the completion of the daily tasks exceed five or six hours, and this is especially true during the period of rapid growth and sexual development. The experience of the best teachers proves that primary-school scholars cannot be kept at real work more than three hours a day, without producing a mental and physical strain. Hence, the system by which young children are kept in school the same number of hours as those who are older,

is wrong from every point of view, and should demand serious attention.

I have alluded several times in the course of this lecture to certain periods of life, during which hygienic errors become particularly dangerous. To these periods it may not be wholly uninstructive at this point to more fully refer. There are four epochs in the life of the child and youth, which mark physiological changes in their nervous systems. The first is when the infant arrives at the period of primary dentition; the second, the commencing irruption of the permanent teeth; the third, the age of puberty; and the fourth, the completion of dentition, the so-called cutting of the "wisdom teeth." The altered condition of health, so often noticed in children at these different stages, is but the expression of constitutional changes going on, of which changes the irruption of the different groups of teeth are but the symptoms. The dangers of the first period — the cutting of the first temporary teeth, particularly if this occurs during hot weather — are usually recognized, and the infant is carefully tended in order to avoid any evil results. But the perils attendant upon the other epochs which have been mentioned are not so commonly realized. These perils are not certainly as great as in the early stages of life, on account of the more advanced state of development of the nervous system; but still they may be, and often are, sufficiently pronounced to leave a lasting impression upon the child's future health. For it is just at these periods, and particularly at the age of puberty, that impaired digestion, disorders of the brain and nervous centres, and pulmonary affections may be

engendered, unless strict attention is paid to all hygienic details. Hence it is that physicians lay so much stress upon the vast importance of exercising a wise care both for the body and the mind at these times, since habits, whether physical, mental, or moral, which are then formed, are very likely to become permanent.

Not only should the hours of study be curtailed within hygienic bounds, but strict attention should also be paid, that a young child is not confined too long at any one study. Mr. Edwin Chadwick, in his work on "Half-Time System in Education," says that a child from six to seven years old is able to attend to one lesson for fifteen minutes only; from seven to ten, for twenty minutes; from ten to twelve, about twenty-five minutes; and from twelve to sixteen, about thirty minutes. In England the half-time system provides for three hours attendance in school, and for the rest of the working hours, employment in factories, in shops, and on farms. Over one hundred thousand children are thus taught, and it has been found that they make as much progress as those who attend school six hours a day. I look with great interest to see some such plan extensively carried out in this country, — a plan which I am certain will result not only in the improvement of the physical condition, but also in a more practical education for those who will be obliged to earn their livelihood by the labor of their hands.

In considering this subject of the proper number of hours for study, it has always seemed to me a radically wrong principle, that, in those schools which hold but one daily session, this session should be made to divide the working day so unequally. With attendance at

school from nine o'clock until two, the pupils seldom reach home before half past two, at which time, fatigued by long hours of study and confinement, they immediately sit down to a meal, which, under the above conditions, cannot be properly digested, which is also brought too near the one which follows, and which consequently in the short days of the year leaves but little time for the proper amount of out-door exercise. Another minor question in this connection, though not of minor importance, is that of school lunches, an improper attention to which essential to health has produced, and is producing, more harm than is realized in schools having but one session. Some scholars bring improper, indigestible materials to school for lunches, and others bring none at all. Good health and good work under these conditions are impossible. In certain cases, to be sure, milk is sold to the scholars by the janitor; but many do not like milk, and some cannot drink it. A much better plan, therefore, would be to provide something warm to eat for those to whom milk is distasteful. In the Institute of Technology this plan has been tried, and has resulted in a marked improvement in the health of the pupils, and consequently in the character of their work. One more point: — the school committee of Boston, with a wise forethought, causes an alarm to be sounded in stormy weather as a signal for one session. But another precaution is needed, and that is the sounding of the same alarm, when the weather in summer is oppressively hot. Apart from the dangers to those children who have to take long walks to school under a blazing sun, extreme heat causes languor and debility, during which mental work becomes arduous, and hence improper.

The system of rank and rewards for the attainment of a certain arbitrary standard, exhibitions and examinations which, properly conducted, furnish a stimulus which may be desirable for boys, are for girls, I apprehend, by no means unproductive of harm. In the case of the latter, the system tends to the development of nervous emotions, such as fear of failure, over-excitation at success, to a much greater degree than with boys,—emotions which lead to the impairment of the nervous forces, thereby provocative of disease. Dr. H. I. Bowditch says, "I have seen not a few patients—scholars—who under the violent stimulus put upon them by an approaching examination or exhibition for rank or for prizes, have sunk immediately after such extra intellectual labor, wholly prostrated in mind and body; and where I have seen them, far advanced consumption was plain. Such cases are utterly hopeless."

No higher duty devolves upon teachers, parents, and physicians, than the earnest consideration of this question of the proper education of girls and young women. But how often is this subject lost sight of; how often not only in our schools, but in all occupations in which women are employed, do we see them subjected to the same routine, the same discipline, the same degree of close application, and to an equal amount of physical and mental fatigue, as are boys and men. This is all wrong, since it tends during the school years to a condition of health which may be productive of chronic invalidism and nervous exhaustion thereafter.

I do not intend by any means to assert that all girls who graduate from our advanced schools leave them in poor health; but I do affirm that while the robust

and strong may pass through the ordeal unscathed, the delicate, the over-ambitious, and those who have inherited tendencies to disease, cannot escape with impunity the too common results of the present system of education. In the light of experience, the question which we should all put to ourselves is, whether the amount of school work has not reached its utmost limits, perhaps overstepped these limits, consistent with a proper regard for the health and well-being of the pupils. I think that it has.

It is not alone, however, in the pupils that we see this evil outcome of the high-pressure system. The teachers themselves, particularly if they are females, too often break down under the strain. As sad as it is to see educational mistakes exemplified in the young, just as sorrowful perhaps it is to contemplate the effects of overwork upon those, who, in their obligations to push forward their pupils to a successful completion of the allotted yearly tasks, are forced to perform an amount of daily work, which many men in active business-life could not long endure.

If a teacher could or would, as a daily habit, procure the requisite amount of exercise in the open air, and give to herself — I say to herself, for these remarks are addressed particularly to you lady-teachers — sufficient intermission at noon; if she would eat a proper meal before going to school, without hurry, or anxious haste to assume the routine work of the day; if she allows herself pleasant recreation, and if, finally, she is not obliged to carry the burdens of her school duties home with her, then the number of hours required for the faithful performance of her tasks in the school-room

would not, as a great rule, be productive of harm, provided that the same school-room is in a good sanitary condition. If, however, she should neglect these hygienic precautions, or if, with or without a disregard of them, she is obliged to take to her home detailed tasks; if there, instead of the needed rest, she is forced to prepare averages, reports, and examinations; in other words, if her brain is kept in ceaseless activity from Monday morning until Saturday night, as I firmly believe is too frequently the case, particularly in the spring of the year, when the system is more or less enfeebled, then surely she is overworked, and her occupation becomes a burden.

Intimately associated with the subject of the nervous system, is that of exercise, since upon a proper amount of this physical diversion depends to a great degree the measure of health. This is a particularly important consideration for girls, who, as a class, do not possess the same opportunities for the development of their physiques as boys. Both sexes, however, should have some sort of systematic exercise provided for them by the schools, especially as in cities and larger towns the march of improvement has curtailed the facilities for out-door sports and exercise. This course need not necessarily be one of gymnastics, which presupposes an instructor to see that their form and degree are adapted to the constitution and the requirements of the pupil; but it may and should, for the younger classes and for girls, consist of calisthenics, which, although they may not develop the muscles to any appreciable degree, yet most certainly stimulate the circulation and improve the respiration, at the same

time furnishing what is very important, — a pleasant recreation. But in some form or other, whether it be calisthenics, gymnastics, or the military drill, a system of physical development, properly regulated, should form a part of the school curriculum, and in this should engage, at regular intervals, the teachers as well as the pupils.

I have thus briefly explained some of the leading topics, which enter into a consideration of the subject of school hygiene. In presenting them to you I have painted no embellished picture of existing facts, nor have I portrayed an ideal theory, but one based upon the actual experience of parents and physicians. No one can avoid recognizing the importance of this vital question, nor the responsibilities which it entails upon all who are interested in the education of the young, — responsibilities which are momentous alike to the child, the state, and the nation. For out of the child is formed the citizen, and from the citizen is built the nation, which, to become wise and powerful, must be founded upon the everlasting rock of vigorous health.

When we ourselves shall pass from this sphere, we must leave behind us, as legacies, our children to carry forward, we hope more completely and thoroughly than we have done, the work of our own lives. Learning wisdom, therefore, from our own early mistakes and from those of our ancestors, we should, while we live, seek to exemplify in the young the present advanced knowledge of sanitary laws; and when we entrust them to you teachers through the greater portion of the working-day, it is in the expectation that you will not only strengthen and improve their minds, but their

bodies also. That this latter desideratum is not more frequently reached; that the health of our youth is not more often sustained and improved, is due to no fault of yours. For as much as you may desire to reform hygienic abuses, you are powerless in most instances to effect the needed change. You cannot build the schoolhouses; you cannot plan the ventilation, heating, nor the drainage; nor can you, as a rule, arrange the hours for study, so as to prevent overwork and overstrain. But you can exercise an intelligent care over the nervous system; you have it in your power to recognize that certain peculiarities and certain defects of constitution exist in some children, which must prevent their being judged and trained as others, in whom these peculiarities are wanting; you can enforce cleanliness both in the schoolhouse and in the person of the scholars; you can notice that this or that child is evidently suffering from symptoms which may be the precursors of a contagious disease, which may spread through the school; you can care for yourselves; and finally, and perhaps the most important of all, you can inculcate into your teachings the right principles of sanitation, and in this way exert in the community a powerful influence for good. I know full well how easy it is to theorize over the need for hygienic laws, and how difficult it is to grasp the practical application of them. Hence I am convinced that a great necessity exists for a medical inspector of schools to help you. Boards of health, no matter how excellent they may be (and nowhere in the world are they better than those in Boston and Massachusetts, to whom all honor for their successful efforts in every

sanitary work); no matter, I repeat, how efficient boards of health may be, they cannot, as now constituted, properly cope with all the details of school hygiene. To be sure, such an officer as I have mentioned would necessitate the expenditure of money; but is it not better that there should be such a judicious expenditure of money, rather than an injudicious expenditure of the health, or, it may be, the lives of those to whom we owe such a solemn duty? As such an officer never has been appointed (and I doubt if he ever will be), and in recognition of the importance of hygienic reform in our schools, the new Association comes forward to endeavor to point out, not only the need for leavening the loaf, but to offer the proper advice for its accomplishment.

This is in part its mission, and this its work, — a work which it expects to push into all sections of the State, — a mission which it intends shall teach that hygienic abuses exist much more frequently than perhaps we ourselves have imagined; that individuals and communities cannot with impunity ignore the fact that they are in a great degree responsible for their own health; and finally that, just in proportion as this fact is lost sight of, just as surely as any of the sanitary laws are disobeyed, just so surely will disease continue to prevail, to the detriment not only of ourselves but of our descendants, to whom we are morally responsible for our own neglect of hygienic precautions. In this field of labor we cannot and will not pause, until, as clearly as possible, we are enabled to cry, "Sanitas sanitatum, omnis est sanitas."

VENTILATION AND WARMING.

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I CONSIDER myself peculiarly fortunate, ladies and gentlemen, in having the privilege of introducing this course of sanitary lectures before the teachers of Boston. It is a rare opportunity that is offered, to speak to an intelligent company of men and women about matters of school hygiene. Your attendance here, in such goodly numbers, on this day of rest and recreation from your exacting duties, testifies emphatically that you appreciate the importance of the topic to which your attention is invited. And your appreciation is not misplaced; for to what class of people in the world is the subject of more vital concern than to you whom I address? You represent many homes where the practical application of the laws of health are never out of place. You are members of a profession whose daily work, under prevailing methods, exposes you to enormous drafts upon physical and mental vigor. In the daily routine of school duties, the condition of the school-room itself is not the least important factor in explanation of the tired nerves, the headaches, the physical and mental exhaustion, which are too often accepted as the teacher's cross, to be borne because it is thought to be inevitable.

You represent, too, sixty thousand school-children, the pupils of our public schools, the symmetrical training of whose minds and bodies is intrusted to your intelligent oversight and direction. It depends largely, as I hardly need to tell you, upon the light, the air, the warmth, the furniture and appointments of the school-room, almost more than upon the study-tasks required, whether these children remain at their desks to do their work efficiently and successfully, or suffer detriment by their attendance at school.

To aid in elucidating the laws of hygiene which modern sanitary science has formulated in their special application to the school-room, for the health of teachers and of scholars alike, is, as I understand it, the purpose of these lectures; and it is my privilege this morning to speak of one important branch of the general theme, namely, of ventilation.

And I venture to remark, at the outset, that there is no topic connected with sanitary science which has received so much attention as this, none about which so much has been written in books or spoken in lectures, which has given rise to so much varied discussion, fanciful theorizing, impracticable invention, as well as scientific investigation. It has taxed the ingenuity of the architect, and has tested the speculative talent of the sanitarian. It has excited warm dispute between rival originators of so-called systems of ventilation, and has put into the market a multitude of patent devices designed to solve the question of the best way to supply pure air to enclosed spaces.

All this is good proof of the importance of the subject in its bearings on public health; and although it can

scarcely be said that there is yet that unanimity of opinion among sanitarians and architects and builders that would seem to be desirable with reference to the methods by which the wished-for end can be gained, there is nevertheless entire harmony concerning the end itself, — the vital consequence of pure air as a fundamental condition of healthy living. "In modern hygiene," says Playfair, "nothing is more conclusively established than the fact that vitiated atmospheres are the most fruitful of all sources of disease."

This feeling about the theoretical importance of having pure air to breath is shared to a large degree by intelligent people who are not supposed to make such matters a special study. Scarcely anybody will demur when you tell him how necessary it is to health to have clean, unpolluted air in his house. He will say that ventilation is very desirable as a matter of course; but if you go with him to his house, you will generally find that he by implication makes reference to his neighbor's premises, not to his own. In the great majority of modern dwelling-houses and public buildings, it would seem that particular pains had been taken to defeat ventilation, not to promote it. With all the enlightenment and instruction and investigation of recent times, our people are lamentably lacking in the means by which the subject should literally be "brought home" to them. The theme has been ventilated, but that is about all.

Now when we use the word "ventilation," what do we mean in exact terms? Primarily, we mean a renewal of the air of inclosed places, a substitution of pure air for foul air, a restoration of the air of inhabited rooms

to its normal state of purity. In this view, the problem of ventilation seems a simple one. Undoubtedly it is easy to renew the air of our rooms by opening the doors and windows. But there is immediately interposed another element in the case, namely, that of warmth. The two subjects of ventilation and warming belong together; they cannot be dissociated. We may ventilate our rooms, but they will be rendered cold in the act; we may warm our rooms and vitiate the air in the process of shutting out the cold and keeping in the heat. The two matters must be harmonized, and therein lies the difficulty.

Fresh, pure air is the great natural disinfectant and antiseptic, and is not to be compared for a moment with any of artificial contrivance. There is plenty of it in the world, and every human being is entitled to his full allowance; yet, disguise the fact as we may, there is no getting over the unwelcome truth that to provide it in abundance in our climate is expensive, since, during seven months of the year, it must be artificially warmed. To take in air at the average winter temperature of 28°, raise it to 68°, and discharge it again, if only as often as once in an hour, is a process which cannot be accomplished without paying roundly for it; yet upon no other condition can we reasonably expect the desired results. The better way is freely to admit that it is expensive, but worth all it costs in money and trouble.

In our study this morning of the subject, I propose to ask your attention first to the constitution of pure air; then, to show in what directions vitiated air differs from pure air, and in what manner pure air becomes spoiled; and, finally, to indicate the methods which

modern science approves for keeping the air of inhabited rooms in a fit state for respiration.

As a point of departure for our consideration of the problem of ventilation, let us get a clear idea, in the first place, of what we mean by *pure air*. Let the chemist aid us to an answer to our question. He tells us that the atmosphere consists of several gases and vapors in a state of mechanical admixture, not of chemical union. These constituents may be expressed as follows: —

Oxygen Nitrogen	Chief elements.
Water Ammonia Carbonic acid Ozone Nitrous acid Nitric acid	Elements present in minute quantities.

Oxygen gas, as you know, is the most important of these elements, for most of the functions discharged by the air depend on it alone. The respiration of the entire animal kingdom and the ordinary processes of combustion are solely maintained through its agency, and many of the great changes continuously passing over the face of nature are the result of the action of this potent agent. For a long time it was supposed that the relative proportions of oxygen and nitrogen in the atmosphere were the same under all circumstances; but recent and more accurate investigations have shown that the relation is not constant. The variations are within very small limits, however, and are produced almost wholly by the processes of the combustion of

fuel and the respiration of animals. The researches of the best chemists have demonstrated that oxygen comprises, by volume, about one-fifth of the air in its normal state, or, to be accurate, 2,096 volumes in 10,000.

The properties of nitrogen have very little in them to interest the sanitary student. We know that this gas is without color, taste, and odor; that it is a little lighter than atmospheric air; that it cannot support combustion or respiration, and that, by diluting the atmospheric oxygen, it renders the latter less stimulating. It comprises seventy-nine per cent of the volume of the air.

That water is present in the air is demonstrable by the familiar fact of its deposition on an ice-cold vessel.

The importance of carbonic acid as a constituent of the air has been recognized very fully ever since investigations into the relation of the atmosphere to health began to be made. Very much of the interest attaching to the subject is due to the original researches of two French chemists, father and son, named de Saussure. These patient experimenters found that the air contained more carbonic acid in summer than in winter, during the night than during the day, over land than above water, during seasons of drought than in wet seasons or after a rain, in towns than in fields, on the mountains than on the plains. This last difference they referred to the rains and the moisture of the ground, as well as to vegetation, which diminishes the carbonic acid and increases the oxygen. The average of the results determined by these observers is that normal air contains 4.5 parts of carbonic acid in 10,000 of air, and we

may say that 4 parts in 10,000 is a safe standard mean of purity, and that if this is increased, we shall presently have sensible vitiation of the air in any given case.

The other constituents of normal air — ammonia, ozone, nitrous and nitric acids — are either so negative in their significance or so little understood that their study need not detain us.

Thus far we have studied, somewhat cursorily indeed, the composition of unadulterated air, such as is found at a distance from any source of contamination. But it is manifest that the sanitary student is concerned less with the normal constitution of the atmosphere than with those conditions wherein it is vitiated and rendered unwholesome. If the air which we breathe were constantly and uniformly the pure air of the Scottish highlands or of mid-ocean, many of the problems of sanitary science would be greatly simplified. The question of practical importance is constantly recurring, — how shall we maintain the purity of this agent so that its respiration shall do no harm? It becomes necessary, therefore, to inquire in what way and to what degree the air is contaminated and made harmful, how and how much its natural ingredients are altered in their constitution and in their relation to each other, and what effects this alteration may have on health.

And first, with reference to oxygen. It is clear that the diminution of the relative amount of this life-sustaining agent is the only way in which a change in its normal relation can prove harmful. This is manifest both to reason and by experience. Angus Smith has given us many facts showing conclusively the diminution of oxygen in places where numbers of persons

have assembled, and abundantly proving that attention to small differences in the proportion of this gas is of great importance. He found that the air of the open heaths of Scotland contained, by volume, 20.999 per cent of oxygen; in a sitting-room which seemed moderately close the percentage had diminished to 20.89; in the pit of a theatre, at half-past eleven o'clock in the evening, it was 20.74; in the air of a mine it was 18.27; and in a place so oppresively close that it was difficult to remain in it many minutes, it was 17.20. Upon these small differences, Smith remarks, "Some people will probably inquire why we should give so much attention to such minute variations, thinking that they can in no way affect us. A little more or less oxygen might not affect us; but supposing its place occupied by hurtful matter, we must look on the change as not too small to notice."

The degree of relative humidity which air should possess for wholesome breathing has been the subject of much inquiry. The questions of what is too much and what is too little in the matter of moisture open for discussion the whole subject of climatology. We find under what may be deemed natural conditions, unmodified by artificial agencies, such great differences in the relative amount of aqueous vapor that it is very difficult to lay down exact propositions concerning the healthfulness of a very dry or a very moist atmosphere. Who can decide that the dry air of Minnesota is more salubrious than the moist air of Newport? With our present knowledge there is no reason for inferring that either is wanting in a degree of humidity favorable to health and long life. There are times, it is true, as in the "dog-

days" of our northern summer, and places like the low-lying swamps of the southern coast, in which a warm atmosphere, saturated with moisture, is oppressive; but we cannot positively declare that it is, in itself, to be considered unwholesome. We must not forget, moreover, man's adaptability to changing conditions of atmospheric humidity; he is able to bear and to enjoy considerable alternations of both temperature and moisture. Animal heat is maintained at about 98° Fahr., whether the thermometer registers the temperature of the air at 30° below zero, or at 90° above. So it is also true that man, being himself a reservoir of water, three-fourths of his body being made up of that element, becomes capable of adapting the air about him to his necessities with reference to moisture, by supplying to it through his skin and lungs the watery vapor needed to maintain the proper supply to an atmosphere temporarily made too dry by natural causes. The tolerance by man of air possessing the extremes of humidity is shown on the one hand by the good health of sailors in tropical seas, breathing an air nearly or fully saturated with moisture, and on the other hand by the robust vigor of Arctic explorers in an air at the other extreme of dryness. These observations have an obvious bearing on the popular method of supplying moisture to the air of heated rooms by the evaporation of water held in tanks or other vessels in connection with the heating apparatus.

Ammonia in the air is one measure of the sewage of the atmosphere; it is the result and gauge of decomposition. By itself it is not an impurity. It is not found free, but is combined in town-air with chlorine or sulphuric acid; in country air it is probably in union with

carbonic acid. Wherever the air is foulest, the ammonia will be found most abundant.

But of all the atmospheric ingredients, the alteration of whose normal proportion has been deemed of special significance, carbonic acid has claimed and received the most attention. Chemistry has done much toward assigning to this agent its true place. Formerly it was thought to be the one essential element to be studied in connection with vitiated air, — the poisonous product of respiration, of which oxygen was the antidote. Now, however, while we are far from an exhaustive knowledge of atmospheric impurities, carbonic acid is looked upon as harmful because it obstructs respiration, because, through its accumulation, the oxygen is diminished, and so the air becomes adulterated and its life-sustaining properties are impaired. According to Bernard, when an animal dies from the inhalation of carbonic acid its death is owing to the mere want of respirable air; the action of this gas, therefore, is negative or suffocative, not directly poisonous.

But however innoxious we may consider carbonic acid to be in itself, it is not without great interest as an ingredient of foul air; for it affords us a constant and reliable test of atmospheric impurity. It is the component whose relative amount is most easily and accurately measured; and as the other and more harmful parts of a vitiated air are known to bear a tolerably constant relation to this, we come to look upon the chemical determination of its presence and amount as a trustworthy guide concerning all the rest.

The amount of carbonic acid which the atmosphere may hold before it becomes unfit for respiration is,

therefore, a matter of the first importance to ascertain. The proportion of the gas in pure air is, as we have seen, an average of 4 volumes in 10,000. Parkes states that the ventilation of a room is imperfect when it fails to introduce fresh air in sufficient quantity to remove all sensible impurity, so that a person coming from the external air shall not perceive a trace of odor or any difference between the room and the outside atmosphere in point of freshness. By repeated experiment he found that the organic products of respiration began to be manifest when the carbonic acid of the air of an inhabited room reached the proportion of six-hundredths per cent; in other words, when, by respiration, the relative amount of carbonic acid in the air exceeded by 2 volumes in 10,000 its proportion in pure air.

The amount of carbonic acid which badly-fouled air may contain above the limits mentioned are, of course, exceedingly variable. A great mass of observations has been accumulated by chemists. It is needless to quote many of these results, and I therefore content myself with a mention of some of the more remarkable of them, as follows: —

	Authority.	Volumes of carbonic acid in 10,000 vols. of air.
Pure air	Parkes.	4.0
Barracks at Anglesey	De Chaumont.	19.7
Portsmouth Military Hospital .	"	20.5
Aldershot prison	"	34.8
Boys' school	Roscoe.	31.0
Girls' school (70 scholars) . . .	Pettenkofer.	72.3
London theatre	Angus Smith.	32.0
Metropolitan Railway (London)	"	33.8
Cabin of a canal-boat	Cameron	95.0
Boston school-house[1]	W. R. Nichols.	30.0
" "	"	25.6
" "	"	20.7

The sources of this increase in the carbonic acid of the air are various. A certain portion comes from the vital processes of the animal creation. Combustion is responsible for a considerable part. Angus Smith has estimated that in Manchester fifteen thousand tons of carbonic acid gas were thrown daily into the atmosphere as the result of the combustion of coal in that busy city. Many manufactories emit the gas as a product, not only of their fires, but also of the processes upon which they are engaged. Illuminating gas, also, gives out a large amount as a result of its combustion.

We have now studied the various natural constituents of the air in their relation to life and health, the relation of these constituents in pure air, and their altered relation in vitiated air. We pass now to examine some of

[1] These observations on the air of Boston school-rooms were made in 1875 by Prof. William Ripley Nichols, in the course of an investigation by the writer and himself, whose results are recorded in the Report of the Boston City Board of Health for 1875.

the adventitious matters which are found commonly in the atmosphere.

A vast number of substances, vapors, gases, or solid particles continually enter the air. Many of these can be detected neither by smell nor taste, and are inhaled without any knowledge of the fact by those who breathe them. Others are perceived at first, but in a short time the nerves lose their delicacy, so that, in many cases, no warning is given by the senses of these atmospheric impurities. As if to compensate for this, a wonderful series of processes goes on in the atmosphere or on the earth, tending to keep the air in a state of purity. Gases diffuse and are carried away by winds, and thus become innocuous; or they are washed down by rain. Solid substances, lifted into the air by the wind or by the ascensional force of evaporation, fall by their own weight; or, if organic, are oxidized into simple products; or they dry, and break up into impalpable particles, which are washed down in the rain. Diffusion, dilution by the winds, oxidation, and the fall of rain are thus the great natural purifiers; and, in addition, there is the wonderful laboratory of the vegetable world, which keeps the carbonic acid of the air within limits. If it were not for these agencies, the air would soon become too impure for the animal kingdom; as it is, it is wonderful how soon the immense impurity which daily passes into the atmosphere is removed, except when the perverse ingenuity of man opposes some obstacle, or makes too great a demand upon the purifying powers of nature.

We have not the time to study with much nicety the composition and essential characters of the great number of suspended matters which diligent search by

chemists and microscopists has discovered in the air. The subject is as fascinating as it is vast. I can touch upon its more salient features only.

And, first, of the organic matter which is given off by the skin and lungs of living animals. The amount of this material in the atmosphere has never been precisely determined, nor is it possible at present to estimate it correctly. It must be in part suspended matter, which is made up of small particles detached from the skin and mouth, and partly of an organic vapor given off from the lungs. It has a fetid and persistent smell, which is retained in a room for so long a time, even when there is free ventilation, as to show that it is oxidized slowly. Is is probably in combination with water, for the most hygroscopic substances absorb it freely. The air of an unventilated bed-room in the morning displays its typical characters. It is probably not a gas, but is molecular, and floats in clouds through the air. In a room the air of which is at the beginning perfectly pure, but which becomes fouled by respiration, the smell of organic matter is generally perceptible when the carbonic acid reaches the degree of seven parts in ten thousand of the air, and is very strong when the proportion rises to ten.

Turning now to the study of the dust which is always suspended in the atmosphere, and which is demonstrable by means of the sunbeam admitted to a darkened room through an aperture in the shutter, we come upon an almost inexhaustible subject. The laborers in this field of inquiry have been many, and their patient researches have elucidated many of the problems incidental to ventilation. I can scarcely do more than to indicate some of the results which have been reached. And, first, let

me speak of the living organisms in the air. When the atmosphere is drawn through previously heated glass tubes surrounded by a freezing mixture, these organisms are deposited in great numbers. Angus Smith has estimated that 529,000 of them may be found in a cubic foot of city air. They are in great variety, one observer having determined two hundred forms. Spores of fungi, pollen of flowers, living animalcules, and parts of insects are found; and, with them, mineral substances, such as particles of sand. The microscope finds, too, in atmospheric dust, bits of cotton, woollen and linen fibre, and of human and animal hair. In some cases, articles of furniture supply a portion of the dust; the flock wall-papers tinted green or otherwise by arsenical coloring matters, give off particles of arsenical dust, and, in cases of persons particularly susceptible, may produce grave symptoms of chronic arsenical poisoning.

The ordinary conditions of the unrenewed air of a school-room are quite enough to astonish us, if we stop a moment to think of them. For there are not only the inevitably vitiating effects produced by respiration and the constant activity of the skin in persons who are healthy and cleanly, but the additional exhalations proceeding from unclean bodies, from ill-ordered mouths, from decaying teeth, from dirty clothing, too frequently accompanying the city school-boy or school-girl to the crowded room which is the scene of their daily tasks.

The effects of breathing and re-breathing an atmosphere thus charged with harmful matters are not far to seek. Every one of us must have experienced at some time or other the noxious influence of an air thus vitiated. We all remember the unpleasant closeness, the

headache, languor, and sometimes nausea, resulting. We are told of the poisonous effects, in the form of fever, coming from larger doses of this irrespirable air; and we have heard of the sudden and rapid manner in which, in still larger amount, it kills those exposed to it, oft-quoted examples of which are to be found in the story of the Calcutta "black-hole" prisoners, the Austerlitz prisoners, and the ill-fated passengers of the steamer *Londonderry*.

There is another important thought in this connection. Besides these direct effects of inhaling a foul atmosphere, an indirect and not less significant consequence is recognized. Disease may be powerless in its assaults on the perfectly healthy human system, while it may find lodgement in a body which bad air, by lowering the tone and depressing the vital vigor, has made an easy victim of epidemic influence. Many a case of sickness proves fatal on account of an unperceived prostration of the sufferer's strength by continuous exposure to an atmosphere impure from exhalations from the body, and many children yield easily to contagious disease through the devitalizing effects of breathing an unwholesome school-room air.

But in adducing evidence to show on the one hand the baneful effects of a vitiated atmosphere upon health and life, the beneficial influence, on the other, resulting from improved methods of ventilation, it is not so agreeable to recite traditional examples of wholesale poisoning as to remember, in contrast with such cases, the wholesome power of ventilation to save life. During the 25 years following 1758, when the Rotundo Hospital was founded in Dublin, for the care of new-

born children and their mothers, one in six of the infants died. The hospital, which hitherto had been unventilated, was now altered so as to allow a free supply of air, and for 25 years following this change the mortality was 17 times less than during the former period.

An important preliminary question, before we enter upon the practical details of ventilation, is what amount of air-space should be allowed in a room like a school-room, for each of its occupants? This should be sufficient to permit the passage of the requisite quantity of air into, through, and out of the room, without creating perceptible air-currents in the form of draughts. If the cubic space for each person in the room is small, renewal of the air will necessarily have to be much more frequent than when it is large. Thus, with a space of 100 cubic feet, the contained air must be renewed thirty times per hour in order that the standard amount be supplied; whereas, with one of 1000 cubic feet, only three renewals would be required. What, then, is the minimum of cubic space through which the standard amount of fresh air can be passed without perceptible movement? Prof. Pettenkofer has answered this question by means of experiments; and has found that with artificial ventilation with the best mechanical contrivances, the air in a chamber of 424 cubic feet may be renewed six times hourly without any appreciable air-currents. No doubt, therefore, such an allowance of space would be adequate if proper means of artificial ventilation are applied, and the air is warmed. But with natural ventilation, it would be insufficient. Dr. Parkes maintains that air changed

four, or even three, times per hour is all that can be borne, and this would require an initial air-space of from 750 to 1000 cubic feet. This is far above the usual allowance. In the crowded rooms of the laboring classes, and in many school-rooms, the cubic space for each person would much more often be found to be 200 or 250 cubic feet than the larger allowance. The expense of the larger rooms would obviously be an obstacle to such an ideal standard; but the question with us is not what is likely to be done, but what ought to be done.

Having thus ascertained how much air-space is considered by the best authorities requisite for good ventilation, we are next to inquire what are the means by which we secure a renewal of the air of rooms. How is the air set in motion? In the first place, air may be set in motion by the forces continually acting in nature; these produce the so-called "natural" ventilation. In the second place, we have the forces put into operation by human ingenuity, constituting what is described as "artificial" ventilation. It is obvious that, in practice, there is, in greater or less degree, a constant combination of both classes of forces, but the classification is useful for purposes of description.

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Now, there are mainly three factors which act in natural ventilation; namely, diffusion, the wind, and, in inclosed spaces, the difference in weight of masses of air of unequal temperature. The amount of ventilation produced by diffusion is shown to be entirely inadequate. It depends, for its action, on the property which all gases have of diffusing in proportion to their density. This diffusion goes on between the inner and

the outer air through chinks and crevices left by imperfect carpentry in the walls of dwellings. Indeed, it has been demonstrated by Pettenkofer that it goes on through the solid masonry of the walls themselves, which, though apparently solid, are yet porous enough to permit the constant transpiration of the air. This transpiration is favored by contrasts of temperature. Pettenkofer found that an ordinary room in his house, whose walls were of brick, had its entire atmospheric contents changed once an hour, when the difference between the outside and the inside temperature was 34° Fahr., the doors and windows being shut meanwhile. This power of transpiration differs, of course, according to the material of which the walls are built, it having been found that the free use of mortar promotes the porosity of house-walls.

Secondly, we have the action of the wind as a factor in natural ventilation. The wind acts to effect this result in various ways. If it can pass freely through a room whose doors and windows are open, acting by perflation, as it is called, the result is really beyond anything to be obtained in any other way. Air moving at the rate of only two miles an hour (a rate almost imperceptible out of doors), and allowed to pass freely through a space 20 feet wide, will change the air of the space 528 times in an hour. Perflation is by far the readiest means which can be adopted for removing speedily and effectually aerial impurities from a room; but it cannot always be depended on because of the uncertainty of the rate of movement, for if the air be still, there can be little or no perflation; and, on the other hand, if the rapidity of movement is great, it be-

comes insupportable. A current of cold air moving at the rate of five or six feet per second becomes unbearable. In spite of this objection, however, cross-ventilation ought always to be provided for by means of windows whenever it is practicable, especially in large rooms like school-rooms; and in all intermissions in the school exercises, the windows should be widely opened for the thorough and rapid renewal of the contained air.

Again, the aspirating action of the wind produces up-currents through chimneys and air-shafts, by creating a partial vacuum which is constantly being filled by the column of air beneath.

The mechanical arrangements which have been proposed or adopted to facilitate the action of these various natural forces are very numerous. To use the perflating force of the wind, opposite windows should be made, whose upper sash, reaching nearly to the ceiling, can be lowered as freely as the lower sash can be raised. To obviate the unpleasantness of draughts, some such plans as the following have been suggested: — The window-sash may be so made that the top slopes inward, to direct the entering current of air toward the ceiling; the same end is gained by a wooden screen placed within and against the upper part of the upper sash, and sloping upward. Another plan is to place a glass louvre in the middle section of the upper sash. Or some of the panes may be doubled, the outer pane having an open space at its lower edge, and the inner pane having a similar opening at its upper edge; the entering air thus passing between the two. A fine wire screen is sometimes adjusted at the top of the

window, to unfold when the sash is lowered, and to break and diffuse the entering current of air. The aspirating power of the wind is best utilized by placing some form of cowl or louvre on the chimney or air-shaft. Sometimes these are made to rotate so as to keep the opening of the cowl away from the wind; and sometimes, probably most often in this country, the so-called "ventilator" at the top of the air-shaft is fixed and so constructed with angles and bevels that it combines the cowl with the louvre.

The most scientific, as they are also the most successful, plans for ventilation do not rely on any of these devices for using natural ventilation by means of the action of the winds. They omit any positive dependence on all kinds of apparatus or contrivance operated by passing currents of air, — all kinds of turn-caps, louvres, cowls and the like, — except in so far as they may be made subsidiary to other measures. Such contrivances are not to be trusted, for the reason that they are as uncertain as the wind itself; so that frequently, and sometimes for long intervals of calm weather, when ventilation is most desired, they are good for nothing. During brisk and active winds, any and all varieties of them will produce a considerable fluctuating upward current; at such times, however, the natural ingress and escape of fresh air unassisted is the most ready, so that the necessity for artificial aid is the least urgent. In the stagnant atmosphere often prevailing week after week, at certain seasons of our climate, the need of certainty of change in the air of school-rooms is most imperative. The effect, at these times, of any or all of the various patented contrivances is mainly to impede,

instead of assisting the internal air to escape, by placing an obstruction at the outlet of the ventiduct.

There is another important and very obvious reason why we cannot rely on natural ventilation. It must not be forgotten that, as I have said, during seven months of the year in our climate the direct admission of the external air into school-rooms cannot or will not be borne. Our schoolhouses are built with reference to winter and warmth, and ventilation must be provided for by special arrangements which must include some means for warming the air as well as changing it. This compels the application of what is called artificial ventilation. It aims to solve the combined problem of ventilation and warming.

In all our attempts to ventilate rooms, and at the the same time to preserve a uniform and wholesome temperature in them, we must bear in mind that we are living at the bottom of an ocean of air, which presses equally in every direction, and whose weight and degree of pressure, and their laws, are accurately known. Any portion of this air on being heated expands in volume, and becomes specifically lighter than the neighboring portions, which have, therefore, a greater tendency to fall toward the earth, and thus to push the lighter portion upward. Heated air, thus expanded, ascends, not however from any such power in itself, but solely because it is pushed upward by the fall of the denser, colder, and therefore heavier, air taking its place. These truths are frequently overlooked by contrivers of ventilating schemes; they know the fact that hot air rises, and they think, therefore, that nothing more is necessary than to make an aperture at

the top of the room, and through this the foul heated air will naturally go out. But it will not do so unless an exactly equivalent volume of colder air finds entrance at the same time, to push it out. If no properly devised plan of ventilation is applied by which an ample supply of fresh warmed air is provided, the principle of spontaneous, natural ventilation will come into operation to a certain, but entirely inadequate extent, and cold air will in some way gain admission; for it must be remembered that the fires, and even human beings (who likewise produce heat by consumption of oxygen), keep the air in constant motion by varying the temperature of its currents; they convert the house or room into a modified kind of vacuum, the draughts of which are inward. Thus the tendency of the outer air must be to enter at all possible apertures; if legitimate and sufficient ones are not provided, it will come through all others that are to be found, such as ill-fitting windows and doors, crannies in the base-boards and floors, even through the more or less porous walls themselves. There is danger, indeed, that the supply of cooler air may be drawn from places not desirable as air-supplies, — from sinks, water-closets, drains, cess-pools, cellars, and the ground.

Now, a purely ideal plan of artificial ventilation would require that all these adventitious and hap-hazard inlets for new air should be closed and give place to proper special ducts and openings. It would require that good workmanship should exclude cold and economize heat. It would make the windows, not only tight at their joints, but, by duplicating the sashes, or by duplicating the panes in single sashes, it would make them bad

conductors of heat without interfering with their legitimate office for the transmission of light. It would make the walls double in order that they also might aid in the saving of heat. Practically, of course, this condition of things is not generally attained, and theoretical principles of ventilation do not have an opportunity for their complete application. As Dr. Reid well remarks, in any scientific plan, the apartment to be ventilated is to be deemed and treated as a piece of philosophical apparatus, the results of the operations of which are not to be interfered with by any fortuitous influences. Desirable as this may be from a purely ideal standpoint, we are concerned rather with the question whether sanitarians and architects have united upon any principles which are available for the practical solution of the problem of ventilation.

It must be evident from what I have said that for the effective working of any scheme of artificial ventilation the following essentials are imperatively requisite: —

I. An inlet for fresh air.

II. An outlet for vitiated air.

III. Proper means for promoting the motion of the air-currents in the right direction.

If these three provisions are made for any enclosed space, — sleeping-room, dwelling-room, school-room, or hall, — artificial ventilation is practicable and effectual; if either of them is omitted from the plan, the working of the rest will be a delusion and a disappointment.

And first, of the inlet. It seems superfluous that I should insist on the necessity of obtaining the supply of fresh air from pure, external sources; yet this necessity is so often overlooked that it should be emphasized.

Air should never be taken from the cellar or basement of a building, nor should it have its passage through accidental crevices, or be drawn from any spot likely to become polluted. The size of this fresh-air opening is a matter of importance. Whenever it is provided at all in our buildings it is almost always too small.

The artificial warming of the in-coming fresh air should be considered at this point. I think that we may lay it down as a general rule that air should be tempered to a proper degree before it enters the room where it is to be used, and that any heating apparatus should be regarded as a way-station in the progress of the new air to the place of its destination. Two chief varieties of heating appliance are in vogue for carrying out the plan of warming the air, — the hot-air furnace placed in the cellar of the building, and the high-pressure or low-pressure steam apparatus. Of all methods, the well-known steam-radiator, properly appointed, is the cleanest, the safest, and, on the whole, the most agreeable and satisfactory. The hot-air furnace, as it is usually constructed, is not without danger to health on account of the readiness with which the air becomes superheated, and because of the readiness, too, with which the air may become charged with noxious gases. Undoubtedly, therefore, the best and safest mode of heating now practised is that in which the air, drawn from without the building, is passed through coils of pipes filled either with steam or hot water. It is universally admitted that the true rule about heating the air is never to have its temperature raised above that degree which results from the contact and radiation of metallic pipes filled with hot water or steam. A peculiarly unwholesome

change appears to be wrought in the atmosphere by raising its temperature to any point higher than the boiling-point of water.

It is needless to remark that American people suffer from the superheating of their rooms in winter, a fact so obvious that it will suffice simply to state it. Custom and common consent have established 68° Fahr. as the point below or above which there should be the slightest possible range. How very much more often it is exceeded than otherwise, the observations of every one of us can attest.

Every school-room should be provided with two or three good thermometers, distributed in different parts of the room. This is the only guide which can be trusted for determining the degree of heat. Personal sensations are an unsafe test.

Let me insist again, at the risk of being tedious, that whether one form of heating or another is used, whether it be the furnace in the cellar or the steam-coil in the school-room, each should have a copious supply of fresh, pure, outside air admitted to it, — the furnace by its "cold-air box," so-called; the steam-heater, by an opening through the immediately adjacent wall of the building.

Now, our supply of new air, properly warmed, being ready for distribution, how shall it be delivered to the rooms where it is needed? You know that the usual way with furnace-heat is by a single register or two registers opening from the hot-air chamber around the furnace, and placed in or very near the floor. Whether that is the best way is still an open question among sanitary engineers. Some say that the fresh air, whether it be warm or cold, should be admitted near the ceiling, through

the cornice; others declare that this method does not supply the fresh air where it is required for respiration by the occupants of the room, and that it simply dilutes the layer of foul warm air, which by its lightness occupies the upper part of the room. Nevertheless very excellent results have been obtained by this apparent reversal of the natural current, and rooms whose fresh-air supply is delivered near the ceiling by many inlets appear to present a satisfactory condition, when proper provision for removing the wasted air is made.

Having thus studied the inlet supplying the pure external atmosphere properly heated, we are now to consider the equally important outlets for vitiated air. You are familiar with the usual school-room arrangement. At one side or in one corner of the room is a shaft, usually of wood, in which, either at the top or the bottom of the room, and frequently at both top and bottom, there is a slide or a register under the teacher's control. This foul-air shaft leads to the top of the building to a reservoir or cupola where all the shafts in the building have a common place of discharge to the outer air. The size of these shafts, with their openings from the room, should correspond with those of the fresh-air inlets. They should have as few turns and angles as possible; they should not be placed near the inlets, and they should lead unmistakably to the outer air. Their usual position is near the ceiling, where the most vitiated air is supposed to accumulate; but there is also excellent authority for downward ventilation, especially in schools. In some school-rooms multiple outlets, all leading to the main shaft, are arranged in the floor beneath the seats, with a view to withdraw the expired air

from the place of its vitiation as nearly as possible. These outlets and ducts should be provided with a sufficiently powerful extracting force to overcome the current of heated air which with each expiration tends to rise rapidly. If this expired air rises and then cools and falls, the chance is offered of rebreathing it with all its impurities present.

Thus far we have studied two of the essential elements in the problem of ventilation; we have provided inlets for fresh air and outlets for foul air; but some force must also be supplied to keep the air in motion in the right direction, so that the supply of fresh air, on the one hand, shall be continuous, and that the vitiated air, on the other hand, shall be as continuously withdrawn. And in this important requirement lies the germ principle of artificial ventilation. The methods of accomplishing this end are two: either the air is driven into and through a room or building, the so-called system of propulsion or *plenum* ventilation; or it is extracted from the room or building by the *vacuum* or exhaustion system. The usual, as it is also the simplest and the best, method is that by exhaustion, the motive force being applied to the out-going foul air instead of to the in-coming new air. And of all the forces at our disposal there is none that can rival the application of heat for this purpose. The principle here applied is a constant one, no matter in what form you may find it. It consists in heating the air contained in the foul-air shaft, and so developing an upward current of greater or less activity, whose action tends to suck in, at all the points of ingress to the shaft, relays of air from the adjacent apartment.

The fire-place with its chimney is the best type and illustration of this method, although it is hardly practicable for school purposes. There is a constant current up the chimney, when the fire is burning, corresponding in force with the size and height of the chimney and the degree of heat from the fire. Concentric currents of air in the room tend toward this outlet, to be withdrawn with the smoke up the flue. With all its advantages for purposes of warmth, I would yet extol the open fire-place as a "ventilator," and as in that respect performing its highest functions.

And the moral effect of the open fire ought not to be forgotten while we praise it for the health and comfort which it promotes. The poet's pen and the painter's brush have recognized this, and have given a special attractiveness to the fireside. The hearth-stone has become synonymous with the home, and is associated with the most intimate domestic relations. But the association dwells rather in tradition than in any present fact. The poet's rhapsody and the painter's fancy could never be inspired by the hole in the floor which we call a "register," or by the rattling columns of the steam radiator. Let us by all means, in our homes at least, have the open fire-place, whatever else we have to promote pure air, equal warmth, and good cheer.

A modification of the fire-place and smoke-flue arrangement for the discharge of the foul air is the use of a chimney, not as a smoke-flue, but as a shaft or ventiduct. This shaft is heated by a fire at the bottom, and just above the fire there enter the foul-air pipes coming from the different rooms. Dr. Reid for several years ventilated the Houses of Parliament in this manner, and so

powerful was the up-draught that, it is said, he could change the entire air of the building in a few minutes. In Gen. Morin's plan for heating the public buildings in Paris, the boiler for heating the water for the steam-pipes was placed at the bottom of the foul-air shaft, and the air of the shaft was still further warmed for induction purposes by coils of pipe arranged within the shaft before they were carried to the various rooms. Still another effective method is to construct alongside the constantly heated smoke-flue another flue which shall serve as an extraction shaft, the chimney imparting sufficient heat to the shaft to maintain an upward current in continuous action. Another arrangement utilizes the smoke-flue by making this flue of iron, and placing it within an ample shaft into which the foul-air ducts from the various rooms discharge.

In schoolhouses, it is generally thought to be sufficient to make the shaft, cut the square holes in its side, and trust that the foul air of the room will instinctively find its way to its proper exit and courteously withdraw from the premises. No means whatever are, as a rule, applied to coax the current in the right direction. There is no steady up-draught in these long boxes to promote ventilation by exhaustion, by drawing the heated and vitiated air through the apertures, and sending it on its way to the roof. The remedy is simple if the architect would think of it and the janitor would apply it. Let there be placed within the shaft, at the bottom and along its course, gas-jets or oil-lamps, constantly lighted. The heat from these would make the desired upward current, and the problem would find its solution, with rare and readily-understood exceptions.

If this application of heat, or its equivalent, is omitted, the ventilator is a delusion and its practical usefulness is a matter of chance.

We have now considered the elementary principles of the combined problem of warming and ventilation. In this study, I have tried to keep in mind the fundamental objects in view, and the simplest method for the attainment of those objects. Of course the principles enunciated are susceptible of great variety in their practical application. Into all these matters, touching the details of appliances and construction, I have not thought it necessary to lead you. It has been my object, rather, to show you that in every scheme of ventilation, natural, artificial, or composite, three things are imperatively essential: first, a proper inlet for fresh air; second, a proper outlet for used air; third, proper management of heat at the inlet and the outlet. Failure may generally be attributed to a greater or less neglect, either in construction or in administration, of one or the other of these essentials, which, simple as they seem to be in statement, are, nevertheless, frequently overlooked or ignored in practice.

I venture to add in conclusion half a dozen comprehensive practical maxims which teachers may usefully remember in their management of the ventilation and warmth of their school-rooms.

I. The *purity* of the school-room air is the one thing most emphatically to be desired; hence, —

II. The teacher should never close the register or the valve behind the steam-coil, these being the only inlets for fresh air when the windows are closed.

III. The teacher should keep the sliding door or

register into the foul-air ventilating shaft always open, that being the outlet for the used or vitiated air.

IV. The temperature of the school-room should be maintained, as nearly as possible, at 68° Fahr.; and a thermometer on the teacher's desk, or in some other easily accessible situation in the room, should be the only guide for determining the warmth, and this guide should be frequently consulted.

V. School-rooms are generally too warm. If the thermometer indicates 70° or more, raise the lower sash of one of the windows, and place under it, so as to fully close the lower aperture, a thin board; the air enters between the upper and the lower sash, and does not cause a draught which can be felt.

VI. At every intermission in the school-exercises, the windows of every room should be opened at the top and bottom, for a longer or a shorter time, according to the external temperature, in order that the entire body of air may be renewed thoroughly. But it is always unsafe and imprudent to open the windows while the scholars are sitting quietly in their seats, since the free and sudden admission of a full blast of cold air is almost as harmful as continued breathing of unrenewed air.

THE EYES OF SCHOOL CHILDREN.

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Since all our knowledge of books comes to us through the eyes, it is of the greatest importance both to the teacher and the scholar to use every means to protect the eyes from injury and to increase their usefulness, and I wish to call your attention in this paper to some of those changes which are most likely to be developed in the eyes during the school years, as a result of study, or which, existing from birth, form a constant hindrance to the free use of the eyes on books.

The greatest danger to the health and usefulness of the eyes that comes from our present methods of education is the alarming increase in the development of near-sightedness. This may be seen on a large scale among the Germans, for nearly sixty per cent of their scholars over twenty-one years of age are near-sighted. The prevention of this condition is now occupying their most serious attention, for near-sightedness or myopia, as it is more properly called, is not a mere inconvenience; it is caused by changes in the shape of the eyeball, and these changes are generally accompanied by diseased conditions of the internal parts of the eye, which tend to increase rapidly during the school years, and in extreme cases may even lead to blindness: a

strong tendency is also developed to transmit these changes from parent to offspring.

A healthy normal eye is nearly spherical in shape, and when at rest sees distant objects distinctly; for by the nice optical adjustment of its anterior parts, parallel rays of light are brought to a focus exactly on its retina; but in the near-sighted or myopic eye the shape of the eyeball is changed by being lengthened backwards, thus becoming more egg-shaped, the rays of light are no longer focussed on the retina but at some distance in front of it, and distant objects are not seen distinctly, unless by using a concave glass we get such a divergence of the rays of light entering the eye that they are brought to a focus further back.

This increase in length, which may even reach 8 mm., is not the only alteration which occurs in a myopic eye. There are other and more serious changes which often take place in the delicate structures about the entrance of the optic nerve into the eyeball, and in some cases the retina itself may become so much affected as to destroy its perceptive power.

The exact means by which these changes are brought about is even now a disputed point; all authorities agree, however, that long-continued work at short distances during childhood will cause them, and it seems probable that this work causes a congested state of the blood-vessels of the eye, especially when the head is kept bent forward, and the hygienic surroundings are bad, which leads to a slow form of inflammation and a diminished resistance of the tissues of the eyeball allowing them to give way and alter their shape more easily. Another cause is the lateral pressure of the muscles

which are used to turn the eye in any direction and keep it fixed upon its work; these six muscles are attached to the white outer coat of the eye, and together they form a funnel-shaped opening in which the eye rests. Now when the eyes are turned constantly inward, as in reading, these muscles press upon the equatorial region of the eyeball, and by increasing the intraocular pressure, cause the eyes to give way at their posterior part where they are least supported, and so cause a continual lengthening backward of the axis of the eye, which goes on during the years of greatest bodily development, say from twelve to eighteen, with increasing rapidity, and if it reaches a high degree, may continue to progress afterward notwithstanding every care.

These changes are not confined to alterations in the shape of the outer membranes of the eye, for if we examine the interior structures with the ophthalmoscope, we find other and more serious alterations. Generally the parts about the optic nerve are thinned and altered in their structure, and these changes may extend to the central portions of the retina, causing a great falling off in the acuteness of sight, and making reading difficult or even impossible. In some extreme cases the retina, unable any longer to follow the other tissues of the eyeball in the extension backward, is separated from the parts beneath, and the eye then becomes suddenly and permanently blind.

These changes in the deeper parts of the eye creep on insidiously, for there is no outward sign by which they can be recognized; but that you may not think them uncommon, the figures of Steffan showed that of

507 near-sighted eyes, 42.4 per cent had the changes mentioned as occurring about the optic nerve, and in 14.42 per cent the central portions of the retina were also affected.

In investigating the causes of blindness, Cohn found that separation of the retina occurred in 4.6 per cent, and the central changes in the retina resulting from myopia in 6.3 per cent of the cases, blindness being considered as such a falling off in the acuteness of sight that the eyes could no longer be used to work with.

The principal cause of these near-sighted changes is the long-continued use of the eyes on near objects during the years of most active bodily development, say from twelve to eighteen. At the age of eight there is very little myopia. Dr. Cohn found about one per cent among young German children in a village school. Drs. Loring and Derby found among the school children of New York, from six to seven years old, three and a half per cent; but as the children grow older and use their eyes more constantly for book-work, the increase is very great. Dr. Conrad found among German school-children of nine years, 11 per cent of myopia; at eighteen it had increased to 55 per cent, and at twenty-one years to 62 per cent. Dr. Loring found among American children of corresponding ages 3.5 per cent, 20 per cent, and 27 per cent.

The following table of Dr. Cohn is especially instructive, for it shows not only the marked increase in the number of myopic eyes in the higher schools, but also the steady increase in the grade or amount of the near-sightedness in the different schools.

	Average percentage of myopia.	Average amount of the myopia.
Country schools	1.4	$\frac{1}{24}$
Primary "	6.7	$\frac{1}{23}$
Intermediate schools . . .	10.3	$\frac{1}{22}$
Polytechnic " . . .	19.7	$\frac{1}{20}$
Latin "	26.2	$\frac{1}{19}$
Universities	59.0	[illegible]

In this increase of near-sightedness there is, however, one fortunate limitation, for after adult life has been reached, and the school and college work has been completed, this increase of myopia generally comes to a standstill, unless the changes have already been extreme; and if one has reached his twenty-first year without developing any near-sightedness, there is very little chance of beginning these changes even with a large amount of near work. For instance, among watchmakers, jewellers, and others whose occupation obliges them to use their eyes constantly at short distances, there is only a small proportion of near-sightedness, but these men generally begin their special work after they have passed their eighteenth year, when the tissues of the eye and of the body have acquired a firmness and maturity; and also much of their work is done with the aid of a magnifying-glass, which lessens the danger, and relieves to some extent the strain upon the ocular muscles. While the eyes are well and strong we are apt to forget how very complicated a process reading is; for the different muscles of the eye work together so quietly and without any voluntary effort that it is only when we overtask them that we begin to discover their complexity of

action. When a child reads a book, two sets of muscles are brought into play. With one set the power of the eye is increased by changing the shape of the lens, so that the rays of light from the book are brought to a focus properly on the retina; by the other set the axes of the two eyes are turned toward each other so that they are united at the point looked at, and with the eyes in this relative position they are made to follow the lines of print back and forth across the page.

This intricate muscular action can be carried on unconsciously by a normal eye for a reasonable length of time, but if we try to prolong the use of the eyes hour after hour without sufficient interruptions, we find that the eyes become congested, that they begin to be painful and tired; and if the child is young, that we are beginning to lay the foundations for myopic changes.

If the scholar bends over his task, resting the head on the hand, or if he strains the eyes by reading bad print with insufficient light, he only increases their congestion; and if when the school hours are over he has no outdoor game to rest his eyes and give him bodily vigor, but goes home instead to prepare his lessons for the morrow, he may be adding something to his present stock of knowledge, but he is doing it with the chance of lessening the power of his most important sense of sight.

The popular idea that near-sighted eyes are stronger than others is a mistake; it comes from the ability which they have to see small objects, such as fine embroidery or print with greater clearness than other eyes, owing to the work being held nearer the eyes, and the images on the retina being larger. Again, these myopic eyes do not have to put on glasses for reading at an age when

other people require them, but this ability must not be presumed upon; for the strength of such eyes is only apparent, and no account is taken of the deeper seated changes which they have often undergone, or of the danger of more extensive complications which may result in case they are abused.

To show what effect the increase of hours of study seems to have on the eyes of children, Erismann found as one result of his examinations, that of those who studied two hours daily seventeen per cent were myopic, of those who studied four hours there were twenty-nine per cent, and of those who had six hours there were forty per cent of myopic eyes. These figures were taken from German children, and with them the strong hereditary tendency probably had something to do with the large percentage obtained; for although it appears that myopic parents very seldom have children who are near-sighted at birth, yet in their descendants there seems to be inherent a greater tendency to develop near-sighted changes, and a greater rapidity in their increase.

In examining the children of some public schools in New York, Dr. Loring found that among those of German parentage twenty-four per cent were near-sighted; those of American descent showed nineteen per cent; and those of Irish parentage had only fourteen per cent; while Dr. Callan found among five hundred colored children three and two-fifths per cent myopic in one school, and one and one-fifth in another. These figures seem to show that the children of those nationalities where study and eye-work are most common have the larger proportionate amount of myopic change; while

those accustomed to the greatest amount of out-door life, and using their eyes almost entirely for distant things, are comparatively free from it.

It may be said that examining the children in different classes of a school gives one result, but that it would be more conclusive to trace the changes which occur in the eyes of individuals, following them through their school life. These examinations are much more difficult to make, as they involve a series of careful observations extending over a number of years; but one case reported by Dr. H. Derby will serve as a type of such examinations, and shows this progressive change to a marked degree. Here both parents were near-sighted, so that a strong hereditary tendency existed. When the eyes were examined at ten years of age, the right was normal and the left had only a slight myopic change; at twelve both eyes were alike slightly near-sighted; at fifteen this change had increased three-fold; at seventeen it was five-fold; and at nineteen years of age the myopia was seven times as great as at the second examination.

Among the Germans the prevention of near-sightedness or its mitigation has been carefully considered, and the new schools with their many improvements have already shown, in some cases, a relative decrease of myopia among their scholars.

The first requisite of a good school-room is sufficient light. This is best arranged so as to fall principally on the left side of the scholars; but it must be sufficient in amount, and if the windows on the left do not give sufficient light, those on the right or behind may be also used; but the scholars should never sit facing the light.

The school-rooms should be high, both for purposes of ventilation and to allow the windows to be carried up to such a distance that the desks furthest from them may have a good light. The French law of 1880 requires that the top of the window shall be at a distance from the floor equal to two-thirds the breadth of the room, and a French commission recommended in 1881 that from each desk in the school-room there should be a strip of sky visible at least thirty centimeters wide, measured from the top of the window. This would, of course, require an open space about the school, and no very high buildings in the neighborhood. A better test would be the ability to read the finest test-type at a distance of 50 cm. at the most poorly lighted desk during the darkest part of the school hours. Cohn found that among the twenty primary schools that he examined, the percentage of myopia varied from 1.8 to 6.6 in the better lighted buildings; but in those schools that were placed in the older portions of the city with narrow streets the proportions rose to 7.4 and 15.1 per cent.

Not only the height of the windows but also their area is important, and many different standards have been given for this. Cohn insists on a minimum amount of one square meter of window surface to every five square meters of floor. Erismann puts the proportion at 1 to 4.5, while the Brussels commission require only 1 to 6. The bottom of the windows should be about 1.5 meters from the floor. Direct sunlight falling on the scholars is to be avoided, and a good arrangement of curtains is to have them roll both from the top and the bottom of the windows.

The tint of the walls may be of any light color, pref-

erably a light gray, but the ceiling should be white. Dr. Fuchs describes a very satisfactory arrangement which has been carried out in the drawing schools of Lütich, where in each room two electric lights are hung half way from floor to ceiling; under each light is a concave mirror large enough to surround the light and screen it from those in the room. These mirrors throw the light to the white ceiling, whence it is reflected as a uniform diffused light over the whole room, giving a pleasant illumination which is very comfortable to the eyes.

Careful attention should be paid to the seating of the scholars and their desks. Fuchs says, "The scholar has a proper position when his body is vertical with pelvis and shoulders parallel to the edge of the desk, and the head straight or only slightly inclined forward. The feet should rest on the floor and the back be supported by a rest. In writing, only the forearm, and not also the elbow, should rest on the desk." In order to accomplish this several sizes of desks will be needed, adapted to the different heights of the scholars, or the London plan of a desk with adjustable seats and foot-rests could be used. The distance from the seat to the top of the desk should be two centimeters greater than the space from the elbow to the seat when the arm is held at the side. The top of the desk should have an inclination of about 1 to 6 for writing, and should project backward so as to overhang the edge of the seat by two or three centimeters; but as this would interfere with the free movement of the scholars in standing up or stepping out of their desks, the top should be arranged to push forward. The seat should be raised above the floor the

length of the child's leg, measured from the sole of the foot to the under side of the thigh when the knee is bent at right angles; it should be deep enough to support the whole length of the thigh, and should have a proper support for the back; for not only is myopia caused by faulty positions and furniture, but some of the commoner forms of spinal curvature may also be traced to this source.

In reading, the book should be held so that the surface of the page forms a right angle with a line drawn from it to the eye, and while reading it is best to avoid all stooping positions and to keep the head nearly erect. The scholars should not be obliged to keep their eyes fixed on their books, but rather be encouraged and instructed to look every little while at distant objects; for by these means the eye is rested, the tension of the muscles is relaxed, and the congestion of the eye is relieved. If one tries to hold his arm horizontally for five minutes, he will get a clear idea of the pain and fatigue which comes of keeping the muscles in a fixed condition; yet we often call upon the ocular muscles for uninterrupted work, not only for a quarter of an hour, but often for much longer periods, and, although it may seem a small matter, yet this interrupted use of the eyes will enable them to work for a considerable time with much less danger and pain than would otherwise have been felt.

The makers of school-books and the committees who choose them have something to answer for in increasing the number of near-sighted eyes; but in this respect American children are more fortunate, for their books are generally printed with much better type and on better paper than those issued in Europe.

Among the Germans the confusing text, the bad type and paper which have often been used in the books for younger children, have been one of the causes of the national myopia. In all their scientific books the gothic type is now abandoned, and if it were not for a national pride in things purely German, this reform would probably have extended itself to their other literature.

In selecting school-books care should be taken that the paper is sufficiently thick and white, for white paper gives a better contrast with the black letters than any colored surface, and also reflects more light, thus making the page more easily legible. It is interesting to note here the distinction that has been drawn between visibility and legibility by different authorities, for it throws some light on the process of reading and on the proper standard for print. Javal says a letter is visible as soon as it is recognizable as a distinct object even when one cannot name it, but it is legible as soon as it can be named. Fuchs, however, says, "A letter is visible when we see it under such an angle that we can distinguish all its parts, so that, for instance, if it was a character unknown to us, we could draw it. The letter is legible when we can name it. In the latter case we do not need to see all the parts; our practice in reading often enables us to guess at the letter when we only see some parts of it. This is still more the case with words or sentences." "Children generally have a greater acuteness of vision than adults, and can therefore see the letters at a greater distance. On the other hand, continuous sentences must be held nearer than is necessary for adults in order to be legible, for the children are less

practised in guessing the letters. From this comes the necessity of using larger type for the books that are to be used in the earlier classes than would be necessary farther on." "For the practised eye the legibility of a print depends not only on the size (height and breadth) and form of the letters, but also on the relation of the letters to each other. The legibility generally increases with the distance by which the letters and words are separated, as well as by the space between the lines."

Cohn gives as the minimum size of the letter n, height, 1.5 mm.; breadth of different parts of the letter, 0.25 mm.; space between two consecutive letters, 0.75 mm.; space between the lines, 2.5 mm.; and length of the lines, 100 mm. Other authors give very similar figures, putting the space between the words at 2 mm., and between letters at 0.5 mm. A good example in which these conditions are nearly fulfilled is the history of Montcalm and Wolfe by Francis Parkman. Diamond editions of books should never be given to children, and fine map drawings, or embroidery, or any school work that needs to be held at less than 35 cm. in order to be clearly seen, should be abolished.

In many German schools the use of the ordinary slate has been given up, for it was found that the contrast between the feeble lines made by the pencil and the dark background of the slate were so poor that it exerted a hurtful influence on the eyes. Horner determined the proportion of visibility of letters thus written on a slate to those drawn on paper with ink as 3 to 4. Instead of these, white slates made of some composition by Thirben of Pilsen have been adopted in many places, and the visibility of writing on these as compared to the black slates is stated to be as 8 to 7.

In kindergartens the use of finely-perforated cardboard on which patterns are made by counting the holes back and forth and passing colored threads through them, is often trying to the eyes; and in the earlier instruction in sewing it would often be found easier to use a black thread and white cloth in order to avoid unnecessary labor for the eyes, and to enable errors to be more easily detected. Sewing on white is difficult enough, but when we have a black cloth and a black thread there is so little difference between the background and the work, and so little light is reflected from it to the eye, that the task becomes a very trying one.

In the study of geography the names of places are often rendered indistinct by the coloring of the maps or the fineness with which they are engraved, and instead of expecting the scholar to spend long evening hours hunting for unknown places in his atlas, would it not be better that he should have the places first shown to him on the wall-maps, and their importance fixed in his mind by some associated historical or commercial facts which would excite his interest and assist his memory.

If we compare the amount of work that is laid out for the children of our public schools to-day with what was expected of them fifty years ago, we shall see how much the burden on their eyes has been increased, and we must expect that unless the eyes have gained in strength in order to bear this additional work, that they will show evidences of the strain, and tend to develop into a myopic state, which seems to be actually the case. Fuchs in speaking of the causes of myopia, says it is not alone the German text, or the print, or the influence of nationality, but especially the overburdening of the

scholar with work. Dürr gives a very striking table of the hours of study as compared to the hours of exercise among German, French, and English boys.

	Study hours from the age of 10 to 19.	Hours for exercise between same ages.
England	16,500	4500
France	19,000	1300
Germany	20,000	650

In the lowest classes of the primary school three hours of study, during which the children are required to sit still, should be sufficient, and the amount can be increased in the higher classes. From fifteen to thirty minutes of every hour should be devoted by the lowest classes to some form of intermission, either singing or some form of exercise.

In the grammar and high schools the amount of work should be carefully graded, and the amount of home lessons should be kept within reasonable bounds. The Strasburg commission asked that the hours of home study for these schools be limited to three hours a week for the lowest classes, and from twelve to eighteen for the upper classes. In Berlin some high school classes have thirty-three hours a week of home lessons, and in the Dresden technical school it is reported that thirty-six hours a week of home lessons are expected.

Too much stress cannot be laid on the need of moderation in the amount of home-work required of a growing child, for with this increase of work comes our

greatest and most serious development of myopia. We must remember that this work is generally done by artificial light, often poorly arranged and insufficient in amount, and it comes at a time when the eyes are already tired with the work of the day; and if the unfortunate student is obliged to devote a part of his play-hours to these tasks because he cannot use his eyes by evening light, he is still more to be pitied, for he thus does double injury by cutting off the out-door exercise which would help him to cure the evil, and by taking instead more eye-work, which increases the difficulty.

One of the principal safeguards that English, and to a considerable extent American, boys have, as compared with Europeans of the same age, is in the greater amount of out-door exercise and games that they can indulge in; and in comparing the lesser amount of myopia among English boys with those of German parentage, this factor is thought to be one of considerable importance.

All these out-door games should be encouraged, for by increasing the general health and vigor of the body we find that the tissues are firmer and yield less readily to pressure, the circulation of the blood is more rapid and freer, and the change of shape and the giving way of the membranes of the eye are less likely to occur. Unfortunately the near-sighted child, finding that he is not able to bear his part in many of the games owing to his defective sight, often prefers to spend the time with his books, and thus adds to the trouble already begun.

In the way of dress, tight-fitting collars, or other garments about the neck that compress the veins, and so retard the flow of blood from the head and congest the eyes, are to be avoided.

If all teachers would test the condition of their scholars' eyes at the beginning of every year, they would be able to distinguish those who were lazy and inattentive by habit from those where some physical defect was the cause, and the record so made from year to year would serve as a useful guide to the amount of work that should be required, especially of those scholars who were shown to have an increasing myopia with decreasing sight.

Such a test is easily made by means of a series of letters of different sizes, such as the scale published by Ginn & Company, which is a copy of the scale devised by Monoyer of Paris.

When this card is hung up in a good light, and the scholar is placed five meters, or about fifteen feet, distant, he should be able to read with either eye, tested separately, the highest letters on the card, and, if he can do this, we call his vision normal, or equal to 1. If, however, we find that he can only read half the lines, we call his vision half the normal standard, or 0.5; and thus, at the side of each line, are the numbers in tenths showing what is the proportion of normal vision for the person who can read that line at the given distance of five meters.

If it is found that the sight is defective for the distance, but at the same time the child can read small print easily when held near enough to the eyes, near-sightedness is the probable cause of the defect; but if both the distant and the near vision are defective, the trouble is due to some other cause. He may have an irregularity of shape of the eye, or the eyes may have been impaired by some disease. In the latter case no glasses will rem-

edy the defect, and his lessened power of vision must call for more consideration on the part of the teacher.

The size of the test-letters is graded with great care, so that there shall be a difference of one-tenth between each line, and the whole thing is so simple and accurate that scholars ought to have their vision tested as a matter of routine, say once a year, and a record kept which would be useful to them and to the teachers; for, as the time to help these troubles of vision requiring a proper correction by glasses is in their earlier stages, such a test would often bring to light defects which could be remedied or alleviated, but which might be increased by disregarding them. In case any decided want of visual power were found, the child could be told to ask for medical advice.

The facts which it is necessary to remember in regard to near-sightedness are, that it is caused by a change in the shape of the eyeball, that the principal cause of this change is the use of the eyes for near work during school years, that it tends to increase in amount, that when once formed it cannot be cured, although it can be helped by the use of glasses, and that the principal means to prevent its development or increase are the preventive measures and sanitary precautions already indicated. Another defect of the eye, which also depends on an abnormal shape, is hypermetropia, or, as it may be here called, far-sightedness. In this case the changes are the opposite of those found in myopic eyes, the axis being shorter instead of longer, and the eyeball being somewhat turnip-shaped. This condition has several advantages over myopia, for it does not tend to increase and thus to induce serious diseased alterations of

the eyeball, and during the early years of school life it often escapes unnoticed, because the eye is able, to a certain extent, to accommodate itself to this state of things, and thus neutralize the defect.

In order to explain this condition and its bearing on the use of the eyes, it will be necessary to say a word in regard to the action of this accommodation.

A normal eye when at rest receives parallel rays of light from distant objects, and without effort brings them properly to a focus on the retina. When an object is held one foot distant, the light which comes from it enters the eye as divergent rays, and, if the eye still remained at rest, these rays would be brought to a focus behind the retina, and the object would not be distinctly seen. In order to overcome this difficulty, the eye has the power of changing the shape of the lens through the action of the muscles of accommodation, and, by making the lens more convex, it is able to bring these divergent rays to a focus on the retina.

The mechanism of this process, by which the eye is able to change its focus from far to near objects, was for a long time disputed, and it was not until the beautiful experiments of Cramer in 1851, and of Hemholtz in 1853, that the true method was discovered. They placed a candle at one side of the eye to be observed; then, by carefully watching with an instrument the images of the the candle-flame reflected from the front surface of the eye and the front and back surfaces of the lens, they were able to see and measure the relative displacement of these images which took place when the eye was accommodated from a far to a near object, and which returned to their first position when the eye returned to rest;

and they were not only able to determine that the act of accommodation was caused by this change in the shape of the lens, but they were able to measure its amount.

Any one can easily convince himself of the action of this accommodation by holding a thin veil, say one foot, before the eyes, and looking through it at some distant object; we can see the distant object distinctly, or, if we try to look at the meshes of the veil, we can see them also distinctly by using our accommodation, but we can in no way arrange it to see both the veil and the distant object at the same time.

Our hypermetropic eye with its shorter axis has to use its accommodation even when it looks at distant objects, and the effort that such eyes make is often as great for distant things as ordinary eyes would make for reading. Such eyes can rest only when the person is sleeping or when the lids are closed, and the extra amount of muscular effort that they are called upon to perform renders them peculiarly subject to attacks of pain on reading, and to general discomfort.

When children are quite young, the lens of the eye is quite elastic, and can be changed in shape with comparatively little effort; but as one grows older the lens becomes less plastic, and more force is required to accommodate it, until, with normal eyes, at about the age of forty or forty-five, one generally finds that a convex glass is a decided assistance for reading, as it brings the rays partially to a focus, and relieves the eye of just so much work.

The condition of hypermetropia, unlike myopia, is often present at birth, but it is not accompanied by any

diseased condition of the ocular structures, and if properly assisted by glasses, such eyes can be depended upon for the usual amount of work. In many cases, however, we find a decided tendency for such eyes to have an inward squint. This is often temporary at first, but may become fixed if the hypermetropia is not relieved by glasses, for it is found that a certain relation exists between the act of accommodation and the convergence of the eyes, and that the greater the convergence the greater the accommodation. For this reason a child who is constantly making a considerable effort to correct his hypermetropia by an extra accommodative effort sometimes develops as a result a permanent turning of the eyes, or squint. The use of proper glasses to relieve him of this extra work will often prevent the eyes from turning, or even set them straight if they have not become fixed in this position; but where it has been allowed to continue for some time, an operation followed by use of glasses is generally needed to set matters right, and such an operation should not be unnecessarily delayed, for the turning eye, not working with the other to see objects looked at, tends to gradually lose its power through disuse.

It is often difficult for a teacher to detect this condition of hypermetropia, on account of the ease with which young children unconsciously correct it; but when the system has been weakened by disease, as by scarlet fever, diphtheria, or other trouble, or where the rapid growth of the child has temporarily exhausted its vigor, a latent hypermetropia will often show itself on account of the inability of the weakened accommodative muscles to conceal it. We then find the children complain-

ing that the print which was clear when they first looked at it soon becomes blurred; the eyes have 'a tired feeling,' or are painful after use, or in the afternoon when the child is fatigued or the light is insufficient, and when tried by artificial light. When such complaints are heard the child should have the eyes thoroughly examined, to see what the difficulty may be, and, if possible, obtain relief. In these cases the use of convex glasses is of the greatest benefit. Children with a considerable amount of hypermetropia will sometimes get their mother's or grandmother's glasses, and find that with them they can see much more easily than without; but this has often been treated as a childish notion, and the idea that it was not well for the child to put on old-sighted glasses so early has often led to postponing the needed relief.

These children often appear inattentive, and while a near-sighted scholar reads his book with very little effort, the hypermetrope, on the contrary, has to make constantly increased efforts to see them, and prefers the comparative rest which distant vision gives him.

There is another condition of the eyes which demands the attention of every teacher, both on account of its frequent occurrence and the difficulty of determining, even on careful examination, how much of real and how much of simulated trouble there may be. I refer to the condition known as weak eyes, or asthenopia, which may come in eyes that are anatomically sound, and is rather a functional trouble, interfering with their use, and rendering them unfit for any regular work, than any special form of disease. In these cases there is often a considerable dread of bright light; the eyes are quickly tired

when used for near work, and more or less complaint of pain is made. This may result from the fatigue brought on by too great a strain upon the muscles of accommodation, or it may come from some irregular change in the shape of the eye, or as the result of previous disease of this organ, but it more often occurs without any refractive error or other change, and then seems to be merely a symptom of a general lowering of bodily vigor. After attacks of measles, scarlet fever, or diphtheria, when the muscular tone, especially of the eyes, has been lessened, this asthenopia is most marked, and it should always be borne in mind that while children are convalescing from these diseases they should never be allowed to use the eyes continuously for reading, painting, or any near work, and that after they have returned to school care should be taken not to overtask their strength at first. With whooping cough and measles the danger to life is so slight that the disease is often looked upon as a trivial affair, yet I have known a strong young man of about eighteen, who, after an attack of measles, was unable to use his eyes for half an hour continuously for more than a year, although eventually they returned to their former strength.

During the years of greatest bodily development, when the children are growing rapidly, the strength is often sapped, and we get complaints of inability to use the eyes. This is the period when there is the greatest danger of developing myopia by forcing the eyes to too much near work; but unfortunately it comes about in the middle of the school curriculum, and both scholars and parents are often more anxious to have the child get a double promotion or high rank than they are to consider

and care for the future usefulness of the eyes, and so long as they can be made to do the work, they are pushed forward.

In this fine building you have one room devoted to the best remedy for weak eyes and bodies, namely, your gymnasium, and it should be insisted upon that every scholar, especially those of a more delicate build and near-sighted tendency, should be obliged to use it, care being taken to avoid excess, especially in such exercises as congest the head and eyes; exercise should not be taken in a hap-hazard way, with only the feats of the stronger boys as an example, but the supervision should be as careful here as in any other department of instruction, and the scholars should never be allowed to exceed their strength, but should be shown how they can best develop and increase it, and so go on from the primer to the higher branches of physical exercise. At Amherst College this plan of compulsory exercise has been in operation for some years, and its results have been very satisfactory.

In the want of opportunities for our girls to enjoy the same freedom in out-door games that boys can have, it becomes all the more important that some form of gymnastics should be provided for them; and although nothing can take the place of exercise in the open air, yet it will be a great gain to bring to their attention the need of greater care in the use and development of their bodies, and the importance of all matters related to their health.

In conclusion, let me urge the need of a discriminating care in the treatment of the scholars. We are not all born equal; the eyes of one child will allow it to accom-

plish with impunity tasks that would be dangerous to its neighbor; and although we may be able in many cases to alleviate the trouble, yet the principal care, both here and elsewhere, must be taken in the prevention of disease rather than in its cure after the harm has been done.

EPIDEMICS AND DISINFECTION.

By GEORGE B. SHATTUCK, M.D.,

Visiting Physician Boston City Hospital.

Ladies and Gentlemen: — I have been asked to speak to you about epidemics and disinfection. Regarded from the single point of view of school-life, the subject, though a very important one, could be disposed of quite briefly, and need not occupy more than a small portion of our time this morning. Regarded, however, from the general point of view of the history of epidemics, of their rise, progress, and decline, in different countries, at different periods, under different conditions, social and physical, the subject is a very extensive one, — more suited to a large volume than to a short lecture.

Do not let me cause you anxiety by this statement. It is not my purpose to take more than the exact measure of one hour of your patience. But it seems only proper that you should, at the outset, distinctly understand that there is a rapidly growing and developing science of epidemiology, just as there is of ethnology, of botany, of natural history.

This being premised, we will allow ourselves a hasty glance at the past history of great epidemics, and the present problems in connection with epidemic diseases

which are now exercising the medical mind, before passing on to the local outbreaks of the common infectious diseases with which you, as teachers, we as doctors, and all as citizens, have to do.

We know that, from the earliest historical times to the present day, the human race has been ravaged at varying intervals by pestilences, varying in intensity and at long distances of time in character.

As climates, races, forms of barbarism or civilization, and habits of life have changed, so have disease types and diseases themselves changed. As the discovery of a new continent is followed by an exchange of such fauna and flora as will thrive in other lands, so it is followed, also, by an exchange of such diseases as can adapt themselves to other localities.

By an epidemic, as you well know, is meant a disease which is generally prevailing, which affects large numbers of people at the same time, and indirectly there is an implication that such prevalence is unusual. A disease, on the other hand, is spoken of as endemic when continuously present in a locality, to however limited a degree. An endemic disease may, it must be remembered, assume epidemic proportions, as has so often been the case in the past in our community with smallpox, and still is the case at times with measles, scarlet fever, and diphtheria.

Epidemic diseases invariably belong to the contagious or infectious class. The two terms contagious and infectious, or infective, were originally intended to convey different meanings, and to apply to different modes of propagation; but as it became evident that there are some common diseases to which neither adjective alone

is applicable, and which require both, the terms gradually lost somewhat of their original proper individual meaning, and were used loosely and interchangeably. For instance, leprosy and itch are contagious diseases in the strict sense of being propagated only by personal contact, while malarial fever is an infectious disease in the strict sense of being propagated only by an atmospheric taint, or miasm. Typhoid fever, again, occupies a position somewhere between the two, and is sometimes described as a contagious-miasmatic disease.

But the term contagious having long since drifted away from the restricted sense of personal contact, and having been loosely applied to diseases propagated through the respiration, and otherwise, at a greater or less distance, has become discredited among the more careful medical writers, and the present disposition is to use the word infectious or infective more and more generally, and to restrict the term contagious to the comparatively limited number of diseases propagated strictly by immediate personal contact.

Another familiar and respected medical adjective, long applied to a large class of epidemic diseases, — I refer to the term "zymotic," — is also losing caste. "Infectious" is now allowed to do the work of the term zymotic, a term which will pass more and more into disuse as the theory of the development and propagation of these diseases by simple fermentation gives way before the more recent and probable theory of their development and propagation by specific living and multiplying animal or vegetable organisms.

Although epidemics have scourged mankind from the earliest times, history occupied itself but little with

them until comparatively recent periods. The so-called historians were too much occupied with the names of kings, and generals, and dynasties, and battles, to devote time and labor to mortality tables, or the registration of the melting away of peoples from more vulgar causes. Moreover, a great epidemic was simply an indication of the wrath of the gods, to be appeased by the sacrifice of some bullocks or maidens, or other vicarious offering. It is undoubtedly a fact that, even in times of great wars, more victims among the contestants themselves die or are disabled by disease, than by wounds received in battle. And yet the plague of the middle ages is the first great epidemic disease of which anything approaching accurate records have reached us, if we except Thucydides' accounts of the plague at Athens, — a disease differing in important particulars from any known to us at present.

The plague came from Asia, and ravaged Europe about the middle of the fourteenth century. Many of you are doubtless familiar with Defoe's graphic account of the great plague of London, the pestilence taking possession of the city for three years, from 1665 to 1668, and killing one-sixth of the entire population, principally in the first eight months. The genuine plague of the middle ages still lingers in Persia and parts of Asia Minor, and its increasing activity within the last twenty years, as well as its actual appearance in epidemic form in south-eastern Russia in 1878, after the Russo-Turkish war, have caused those who were informed to reflect seriously upon the possibility of its reappearance in Europe.

Since the disappearance of the plague, the most seri-

ous epidemic maladies which have afflicted the world have been small-pox, yellow fever, and cholera. The discovery of inoculation and vaccination robbed small-pox of its terrors; but you know how semi-civilized people and barbarous tribes, among whom vaccination is not practised, are devastated by this disease when once introduced among them; and you whose memories go back to 1872 know that even with such a weapon of defence as vaccination, it is only at the price of constant vigilance that immunity is secured.

Yellow fever is another epidemic disease which immediately concerns us, in so far as a large section of our own country is very frequently threatened by it; and you can form some adequate conception of its power under favorable circumstances, when I tell you that during the few months of its occupation of Memphis, in the summer and autumn of 1878, it killed as large a proportion of the whole population — notwithstanding the flight of at least one-half before its approach — as did the famous plague of 1665 at London, during the whole three years of its activity in that great city. We have all the hard facts and figures, but no Defoe to make them memorable. Fortunately, there is an antidote to yellow fever in cold, as there is to small-pox in vaccination, and this, in our own country, is never very far distant.

Cholera, though an old disease in India, is without authentic records there until the beginning of this century; and for Europe and our own continent it dates back only to the years 1831–32, since which date it has visited us only five times. Boston has been only once seriously threatened, and that was in the year 1848,

when 611 people died from it. With good management the city may hope to escape as well in the future.

This hasty review of the great epidemic scourges is not unprofitable, as showing that it is not, after all, from them that we in Boston have much to dread. The plague is practically a disease of the past; against small-pox there is vaccination; the yellow-fever zone does not extend to Boston; cholera is a very occasional visitor, and, as previous epidemics show, does not easily make itself at home here. Yet if any one of these maladies were known to be on its way to us, or, much more, to have obtained a foothold in our city, our whole population would be thrown into a high state of excitement, and no expenditure of money or trouble would be considered excessive in combating it, nor should we rest until it was stamped out.

Now, in regard to nothing else is the old proverb that "familiarity breeds contempt" more true than in regard to diseases. We have three diseases domiciled here in Boston, exacting their yearly toll from our population, year in and year out, which are quite as dreadful in their way as cholera or yellow fever; and yet we are content to live on with them as if they were a necessary part of the incidents of our daily life, without doing all in our power to be rid of them. I refer to diphtheria, scarlet fever, and typhoid fever, — all to a considerable extent preventable maladies. It is true that they do not break out with the same explosive violence as cholera and yellow fever, but this is largely due to the fact that a large proportion of the population is being periodically constitutionally accustomed to them. When they attack a perfectly fresh field they develop the

same activity as either of the first-mentioned maladies. Moreover, these endemic diseases periodically take on epidemic proportions. Again, the harm which a disease inflicts is not to be judged simply by its mortality; the length of its course, the subsequent disabilities, the loss of time, are all to be taken into account. From this point of view typhoid fever is a more terrible disease than cholera, although the rate of mortality — about 15 per cent — is scarcely a third of that of cholera, which is about 50 per cent. But a person has an attack of typhoid fever, preceded, as a rule, by a period of worthless malaise, varying from a week to two weeks; and, if he is fortunate enough to recover, it is only, on an average, after five or six weeks of helpless illness, followed by an equal or longer period of inactive convalescence. Again,

Typhoid Fever is a terrible disaster,

in that it not only disables its victims for a long time, but that time is, in the great majority of cases, taken out of the most precious years of life, — between the ages of 10 and 45 years. These results of typhoid can be, and have been, arithmetically computed and stated in dollars and cents; or, if you choose, it can be shown that the loss of so much activity is equivalent to so many more actual deaths, and in this way the real mortality, for purposes of comparison with other diseases, can be more correctly arrived at. Now, typhoid fever and cholera are neither of them contagious diseases; they are both of them preventable if all proper precautions are carefully taken and persisted in, and both of them probably preventable in much the same way. And yet

we are even now preparing against a possible invasion of cholera in the summer, although content to jog along in much the same careless way with our own domestic typhoid fever.

I could go through the same sort of story in somewhat the same way in regard to diphtheria and scarlet fever, did I not think we were by this time sufficiently of one mind in this question to make it unnecessary.

Now, there is one fact concerning all these domestic infectious diseases with epidemic tendencies, except typhoid fever, — to wit, diphtheria, scarlet fever, measles, whooping cough, chicken pox, — which should make them particularly interesting to you, ladies and gentlemen, as a body of teachers, and especially worthy of your attention; and that fact is that the period of their greatest activity in Boston, as elsewhere, coincides with the school months, and the great majority of their victims are among young people of the school age, who are a large part of each day during those months under your care and supervision. It is doubtless owing to this fact that I have been asked to talk to you on this subject; for the dissemination of these diseases and the epidemic proportions they sometimes assume are certainly due in no small measure to the intercourse of children at the public schools.

The Board of Health and the city physician are charged with the health of the city. We look to them to make the dirty places clean and the infected places harmless; to hunt up and isolate the sick, and to protect the well. All this can only be attempted within the limits of the laws, and the laws are only operative in so far as they are in sympathy with public opinion. The efforts of

health authorities are crippled, unless supported by the citizens whom it is sought to benefit. Householders and physicians are required to report to the Board all cases of specified infectious disease coming within their knowledge, and there is a fine as penalty for neglect to comply. But if the cases are not reported, the health authorities can hardly be held responsible for a continuance of the causes which favor the development and spread of the disease. If there is one good thing which a popular form of government should teach, it is self-reliance. Under an absolute form of government, the people are taught to depend upon a central authority to regulate all their affairs for them. It is the boast of the American that he knows how to take care of himself. If this is not a vain boast, it should be demonstrated in nothing more clearly than in taking care of our health, and in preventing disease. The work of health authorities should be facilitated and not impeded. Our citizens should not require to have immunity from disease thrust upon them in spite of themselves.

The history of small-pox since 1872–73, the date of the last epidemic in the city and State, shows what can be done in this direction.

I will ask you to give your attention to the city of Boston alone, and I quote from the reports of the Board of Health. Since 1872 the health authorities have had absolute control of all the means necessary for the suppression or prevention of an epidemic of small-pox in this city. They possess the means for the most prompt isolation, disinfection, and vaccination; and these three measures are enforced in every instance. The result has been very satisfactory, beyond

the occurrence of an isolated case, here and there, which has been introduced from abroad; and this notwithstanding a decided increase in the disease three years ago on the continent of Europe and in England, which made itself seriously felt in other parts of this country. There have been, therefore, only 25 deaths from small-pox since 1873, whilst in 1873 alone there were 302 deaths.

Business has not been disturbed by the prevalence of this dreaded disease, the loss by death has been very small, and the expense to the city trifling. The number of deaths from small-pox since 1872 is shown in the following table: —

1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
302	2	1	2	4	0	0	1	6	8	1

Health authorities and physicians have one great advantage in vaccination for dealing with small-pox, which they do not yet possess for dealing with the other infectious diseases.

From what has been accomplished in the last ten years by Pasteur, Koch, and others, in regard to other diseases common to men and animals, by inoculations with attenuated virus, there are good grounds to hope, however, that in time a similar protection may be found against other maladies. But in the meantime much may be done by isolation and disinfection.

Reports from physicians, of cases of scarlet fever, were called for by the Board in January, 1877, and at the same time an order was passed forbidding children attending school from any family in which this disease existed. A circular of instructions was also issued and

sent to each family where a case was reported. It was thought not to be advisable at that time to interfere beyond these measures with scarlet fever. The record then showed an average of 399 deaths yearly, for the previous ten years, from this disease.

The number of deaths from scarlet fever each year since 1872 is shown in the following table: —

1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
474	269	534	458	104	68	149	33	35	75	211

You will notice that scarlet fever since 1881 is again on the increase. It is not enough to keep children from school when actually suffering from this disease, but they should be isolated until desquamation, which almost always follows scarlet fever, is terminated. At the same time, in 1877, that physicians were required to report cases of scarlet fever to the Board of Health, it issued the following order: —

That no child from any family in which a case of scarlet fever has occurred, or shall hereafter occur, shall, without a written permit from this Board, attend any school in this city until the expiration of four weeks from the commencement of the last case in such family. Such length of time shall be certified in writing by a physician, or some responsible member of the family, the certificate to be presented to the teacher of the school before the child is admitted.

It is my impression that this order is practically a dead letter. I know perfectly the difficulties and annoyances which its enforcement would involve; but until it, or something like it, is enforced, scarlet fever will prevail and frequently assume epidemic proportions. At the City Hospital we have many cases of

these infectious diseases, not a few of which come from benevolent institutions for the care of orphan or deserted children. We are sometimes very much perplexed for want of accommodation for new cases, and a proper separation of different diseases. Under these circumstances we may be forced to discharge scarlet fever patients before peeling is finished; but the common consequence is, that three or four new cases apply for admission, as a result of each one so discharged. In a word, it does not pay.

Diphtheria is an infectious disease prevailing very largely among young children; but we have still little real knowledge as to its mode of propagation, and still less as to its mode of origin. The two most severe epidemics in this State developed without special cause under precisely opposite conditions, — the one at a small mountain town on the highest land at the western part of the State, named Florida; the other at the low-lying, sea-surrounded, sandy island of Nantucket. Isolation and disinfection are, however, fortunately powerful agents in preventing the spread of diphtheria. The physicians and attendants at the City Hospital have a large number of cases to care for all through the year; and yet it is rare that any of them take the disease, and in the exceptional instances carelessness in handling patients, or imprudence from over-enthusiasm, are generally at fault.

Reports from physicians and householders, of cases of diphtheria, were called for by the Board of Health in December, 1877, and a circular of instructions issued and used as in cases of scarlet fever.

The deaths from diphtheria increased in number from

59 in 1873 to 601 in 1881, and then began to decrease as in the following table: —

1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
59	72	420	577	364	448	391	588	601	458	445

Typhoid fever, cases of which physicians have been required to report since 1881, has continued with but slight variation from its record of 1872.

1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
243	202	227	145	156	120	119	154	207	212	198

The record of deaths from measles presents a greater irregularity in numbers, from year to year, than the record of any of the other infectious diseases, and is as follows: —

1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.
16	41	65	2	2	145	2	49	108	25

In June, 1883, measles were included among the diseases to be reported to the Board of Health.

The law of the State in regard to the attendance at school from families where there is sickness is to be found in Chapter 64 of the Public Statutes for 1884, and is to the effect that: —

No child can attend school while any member of its family is sick with small-pox, diphtheria, or scarlet fever, or until two weeks after death, recovery, or removal of such person.

The latest order of the Boston School Committee is based upon this statute, and was issued Nov. 6, 1884. You are doubtless all familiar with it, but it will do no harm to re-read it.

At a meeting of the school committee, held Oct. 28, section 198 of the regulations was amended to read as follows: —

No pupil shall be admitted to any of the public schools without a certificate of a physician that such pupil has been vaccinated or is otherwise protected against the small-pox; but this certificate shall not be required of pupils who are transferred from one public school to another; nor shall any child be allowed to attend any school in the city while any member of the household to which such child belongs is sick of small-pox, diphtheria, or scarlet fever, or during a period of two weeks after the death, recovery, or removal of such sick person, such length of time being certified in writing to the teacher by a physician or some responsible member of the family.

Both the statute and the order are vague in the use of the word recovery, and inadequate (certainly for scarlet fever) in the limitation of the time to two weeks. A physician's certificate should be required for scarlet fever. Of the possible risk in sending a well child attending school, to get news of an absent child suspected of sickness, you are probably all aware. Another statute (Chapter 98) was enacted by the State, entitled "An Act Concerning Contagious Diseases," with the terms of which it is well you should be acquainted. It reads as follows: —

Sect. 1. When a householder knows that a person within his family is sick of small-pox, diphtheria, scarlet fever, or any other disease dangerous to the public health, he shall immediately give notice thereof to the selectmen or Board of Health of the town in which he dwells, and upon the death, recovery or removal of such person, the rooms occupied and the articles used by him shall be disinfected by such holder in a manner approved by the Board of Health. Any person neglecting or refusing to comply with either of the above provisions shall forfeit a sum not exceeding one hundred dollars.

SECT. 2. When a physician knows that a person whom he is called to visit is infected with small-pox, diphtheria, scarlet fever, or any other disease dangerous to public health, he shall immediately give notice thereof to the selectmen or Board of Health of the town; and if he refuses or neglects to give such notice he shall forfeit for each offence not less than fifty nor more than two hundred dollars.

SECT. 3. The Boards of Health in the several cities and towns shall cause a record to be kept of all reports received in pursuance of the preceding sections, and such record shall contain the names of all persons who are sick, the localities in which they live, the diseases with which they are affected, together with the date and the names of the persons reporting any such cases. The Boards of Health shall give the school committee immediate information of all cases of contagious diseases reported to them according to the provisions of this act.

SECT. 4. The Secretary of the Commonwealth shall furnish the Boards of Health with blank-books for the record of cases of contagious diseases as above provided.

SECT. 5. Sections seventy-eight and seventy-nine of chapter eighty of the Public Statutes are hereby repealed.

The following table compiled from the "Massachusetts Registration Reports" — reports, which, though necessarily inaccurate in some particulars, are probably fully as reliable as any published in the United States — shows the yearly variations in the deaths from a certain number of epidemic diseases affecting especially the young for fifteen years, from 1869–1883 inclusive. The total deaths from these diseases throughout the State in each year is also given; and the changes in population are appended at intervals of five years.[1]

[1] At the lecture a large chart was exhibited, showing graphically the yearly variations in the mortality from these and other diseases for thirty years, from 1854, the first year of State Registration, to 1883 inclusive. The first twenty-five years of this interesting and instructive

Years.	Dysentery.	Typhoid fever.	Whooping cough.	Croup.	Diphtheria.	Measles.	Scarlatina.	Cholera morbus.	Small-pox.	Totals.	Population.
1869	481	1205	320	473	296	222	1405	1424	59	5885	
1870	471	1333	330	434	242	269	683	1914	131	5807	1,457,351
1871	389	1116	243	473	274	131	867	1718	295	5506	
1872	564	1703	363	480	273	428	1377	3254	1029	9471	
1873	435	1406	264	435	310	180	1472	2553	668	7723	
1874	366	1147	449	411	502	161	1382	2322	26	6766	
1875	437	1059	242	680	1200	233	1684	2606	34	8175	1,651,912
1876	417	881	192	684	2610	47	1222	2087	31	8171	
1877	580	814	369	544	2634	135	467	1927	26	7496	
1878	602	679	400	583	1934	305	404	1573	2	6482	
1879	372	637	302	559	1734	9	850	1349	7	5819	
1880	395	882	230	625	1769	236	574	2118	38	6867	1,783,085
1881	360	1072	217	677	1706	230	397	1861	47	6567	
1882	398	1079	265	491	1280	68	318	2159	45	6103	
1883	336	860	137	530	1091	321	575	1941	5	5796	

It is evident from the facts presented that all these infectious diseases have their periods of increased activity, of epidemicity, whenever they find ready to hand a large amount of fresh material to work upon. What is practically most wanted, — especially for those diseases against which no method of inoculation has yet been developed, — as the Board of Health, the superintendent and physicians of the City Hospital, and of late the daily press, have repeatedly urged and proved, is sufficient hospital room for the proper care and isolation of every case as soon as the Board of

chart were made under the direction of Dr. C. F. Folsom, when secretary of the State Board of Health, and the last five years were added to complete the chart to the date of the last Registration Report.

G. B. S.

Health shall decide that it cannot be properly isolated at home, and that its condition will permit of removal to a hospital without danger to the patient's health.

There would be no hardship in thus removing the patient, but in very many instances it would be the means of saving life, and the city would be but doing what is imposed upon her by statute law.

All those most competent to judge in this matter, and best acquainted with the necessities of the situation, insist upon the advisability of adding to the present City Hospital buildings another or others of sufficient capacity to accommodate not less than one hundred patients with infectious diseases, this to be so arranged as to isolate safely at least three different diseases at the same time. And it will only be with such accommodations that such diseases can be successfully opposed, and the mortality and disability from them materially and permanently reduced.[1]

Of course you understand that the number of deaths from any of these diseases in a given year is not always an exact indication of the number of cases. The virulence of the poison may vary from year to year, but in a succession of years the number of deaths is the most accurate way of representing the prevalence of a disease, for the deaths have to be reported, — although they may be attributed to a wrong cause, — whereas the cases often are not reported at all.

[1] Since the delivery of this lecture the city government has made an appropriation of $40,000 for the erection of additional accommodation for the isolation of infectious diseases at the Boston City Hospital. The amount appropriated was only half that demanded, and this appropriation was finally secured in spite of some astonishing opposition.

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The time may come when the authorities will be persuaded of the wisdom of providing special medical supervision for the public schools of Boston.[1] At present such supervision as is given is through the Board of Health acting under encouragement or discouragement of the school committee, and with the coöperation of the truant officers. Under such an arrangement the intelligent interest and zeal of those whom you represent, ladies and gentlemen, — of the teachers, — may do much not only for the health of the scholars in the public schools, but for that of the city at large.

In Brussels, although there are many medical inspectors of the schools, the health department has caused to be compiled for the use of the teachers some brief instructions as to the first symptoms of transmissible diseases; these the superintendent had printed and distributed to the members of the corps of teachers. They have lately been translated and distributed among the teachers at Cleveland, Ohio, by order of the Board of Education of that city.

A code of rules for the prevention of infectious and contagious diseases in schools has also been drawn up and published, under the auspices of the "Medical Officers of Schools Association" in England. This code is designed for the boarding as well as day-schools, and is based upon the experience of medical men having supervision of large collections of scholars.

Of course there are exceptional cases to all general

[1] The Boston School Committee has just voted, as these sheets are going through the press, to establish an office of "Instructor in Hygiene." A thoroughly competent and suitable person should have in this position a rare opportunity of promoting the welfare of future generations. An incompetent health officer would be worse than none.
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rules, such as those given in these or other instructions. As an instance, merely, I may mention that a young woman lately came under my care at the City Hospital, with a well-marked scarlet fever rash, but without any fever or inconvenience whatever from the disease. She had been living out in domestic service, doing her work until the day of coming to the hospital, and would have continued so to do had not her room-mate reported her rash to the family, greatly to their alarm.

As another instance, the little "Brussel's Manual" says, in regard to affections of its second class, B., in which fever is not always present at the beginning, that in the initial stage of these diseases depression of spirits is the rule, and there exists a feebleness of mind and body, and marked inattention. I am afraid you, ladies and gentlemen, observe only too many cases of feebleness of body and mind, and especially of marked inattention which cannot be explained by any so temporary cause as developing measles or chicken-pox.

Such rules can only be applied with discrimination, and if sufficiently condensed to be practically useful run the risk of sometimes leading to error.

Disinfection.

A few words now as to disinfection. All disease-poisons are not equally favored or antagonized by the same influences, any more than they are propagated and disseminated in the same way. Cold, which is fatal to yellow fever, and inimical to cholera, is comparatively favorable to small-pox. The germs of some of these poisons can be cultivated only in alkaline media, of others in acid, and of still others in neutral

media. Some of these poisons, as of cholera and typhoid fever, are best disseminated when kept moist, whilst others, as scarlet fever, are more fruitful in the dry state. Some of these poisons are given off from and are absorbed by the alimentary canal, as in cholera and typhoid fever, and in such diseases the discharges from the bowels should be most carefully disinfected, or altogether destroyed. Other poisons, as of scarlet fever or erysipelas, are given off from or enter by the lungs or skin, or any abraded surface. These are pre-eminently the infectious and contagious diseases, and nothing less than absence from the neighborhood of the sick will protect those having a pre-disposition to them.

In general, nature has provided two excellent disinfectants, which are plentifully supplied, and are quietly at work all the time, wherever they are allowed a chance. I refer to sunlight and fresh air. Oxygenation of waste products is the process by which they work, and the same method is pursued in the laboratory by experimenters, who seek to attenuate to any given degree the virus of a poison, and thus adapt it to inoculation.

There are, as you know, a great number of chemical disinfectants, both simple and complex. To be of real value, such a disinfectant must be both cheap and efficient. And a disinfectant which will destroy the spores or germs of one disease, may have no effect or but little upon those of another. Some experiments are now being carried on at the chemical laboratory of the Johns Hopkins University, under the auspices of the American Public Health Association, to determine definitely the value of the best-known and most commonly used disinfectants for antagonizing disease-poisons. Among

such disinfectants, corrosive sublimate, or bichloride of mercury, from its cheapness, its freedom from odor and stain, promises, in the proportion of (say) 1 to 2000 of water, as much satisfaction as anything at present in use.

It is a very common mistake to confound deodorizers and antiseptics with disinfectants. A disinfectant may be a deodorizer in the sense generally of substituting one smell for another, but a deodorizer is very often not a disinfectant at all.

A very high degree of heat — several hundred Fahrenheit — is another method often resorted to, as by ovens, or by superheated steam or boiling water, for destroying disease-poisons, or disinfecting articles of clothing. Dry heat of the same degree is not as effectual as moist heat, and boiling water is a very efficient antagonist to the poisons of most of the common diseases. When dry heat is resorted to, a temperature of at least 250° Fahr. is desirable. It is by a patent apparatus, designed for introducing superheated steam into the interior of the bales, that it is proposed to treat the imported foreign rags as they arrive at our ports. It is a debated question whether such bales are really prone to be infected or not, but this method by which it is *said* that the interior of the bale can be raised to a temperature of 500° Fahr. is supposed to be effectual, and, at any rate, may prove quieting to the public mind.

Where articles can be loosely spread out, their exposure for several hours to the action of sulphurous acid gas, cheaply generated by burning roll sulphur in a tightly-closed room, in the proportion of two pounds to every thousand cubic feet of air space, is an easy and

efficient way of disinfecting them at the same time with their infected surroundings, and this is the method usually employed for disinfecting sick-rooms. Practically, this process proves itself effectual in its application against the usual infectious diseases of our Northern States, though we have no exact knowledge of the power of sulphurous acid gas over individual disease poisons.[1]

It has not been my intention to give you more than a brief outline, in a few words, of important points which it is well you should have in mind in regard to disinfection. Circumstances alter cases very materially in this matter, and for the application of general principles to special conditions, Boards of Health, when medically advised, and physicians, should be consulted.

[1] Since this lecture was delivered, Dr. George M. Sternberg has published results of experiments made with this and other disinfectants, and in a preliminary report on his investigations made under the auspices of the American Public Health Association, he says: "Fumigation with sulphurous acid gas alone, as commonly practised, cannot be relied upon for the disinfection of the sick-room and its contents, including bedding, furniture, infected clothing, etc., as is popularly believed. And a misplaced confidence in this mode of disinfection is likely to lead to a neglect of the more important measures elsewhere recommended. In the absence of moisture, the disinfecting power of sulphurous acid gas is very limited, and under no circumstances can it be relied upon for the destruction of spores (germ seeds). But exposure to this agent in sufficient quantity, and for a considerable time, especially in the presence of moisture, is destructive of disease germs in the absence of spores. It is essential, however, that the germs, to be destroyed, shall be very freely exposed to the disinfecting agent, which has but slightly penetrating power." Dr. Sternberg is disposed to admit the value of sulphur fumigation after small-pox, scarlet fever, diphtheria, typhoid fever, and yellow fever, but thinks that not less than *three* pounds of sulphur should be burned to each thousand cubic feet of air space, and the usual precautions for stopping all apertures should be very carefully attended to. G. B. S.

DRAINAGE.

By FRANK WELLS, M.D.,

Editor of the Registration Report of the State of Massachusetts.

THE important subject of drainage does not, perhaps, justly enter into the practical consideration of school hygiene, as far, at least, as it relates to your ability to improve the sanitary condition of the school-houses and their premises; since, no matter how much the proper management of the ventilation and heating of the rooms, or the care of the eyes and nervous systems of the pupils may be left to your intelligent supervision, you certainly can have no voice in the construction nor in the regulation of that great hygienic factor, — the drainage. And yet, it was thought that this course of lectures, which we have had the honor of delivering before you, would not be quite complete without some reference to a subject, upon which so much ignorance has been, and still continues to be displayed by some even of those who are responsible for the proper construction of dwellings and public buildings. Moreover, it would seem that a brief consideration of the principles involved in creating a perfect system of drainage, and of the evils which arise from a disregard of them, — considerations which enter so largely into almost our daily lives, — might be instructive, particularly at this time, when it is so incumbent upon us all to see that

our houses are in a good sanitary condition, and that we ourselves live in strict conformity with the laws of health. Furthermore, I am not so certain that you, gentlemen and ladies, in your capacities as teachers, intrusted, as you are to a certain degree, with the supervision of the schoolhouses and school-rooms to which you are assigned, may not or should not be efficient agents in the detection of errors or defects in the drainage systems of them, and hence play an important part in the prevention of disease, which, as Dr. Austin Flint says, is a higher and more useful branch of medicine than therapeutics. That many of you are women makes no difference, — rather, it does make a difference; since, remaining more at home than a man, supervising the domestic economy of the house, you become more familiar with every portion of it. "There is nothing in hygiene," says Mrs. Plunkett, "which a woman cannot understand," and too often she awakes to a realization of this, and commences her study of sanitation when it may be too late to save a life, sacrificed to a disease which might have been, with a more perfect knowledge of its cause, prevented.

With these remarks as an introduction, to more clearly explain to you my warrant for adding the present lecture to the course, let us now proceed to the practical consideration of its subject.

It is a sanitary axiom that all water which has been introduced under pressure into dwellings or other buildings, such as stables and manufacturing establishments, must be removed from them, after becoming fouled by the various usages of every-day life. Such refuse water is called sewage, and the system by which it is

immediately removed from habitations, and disposed of in a manner to render it innocuous, is termed sewerage. By sewers we understand the large underground conduits, which conduct off the fluid, or half-fluid refuse which has been discharged into them by the smaller channels from houses, factories, etc., which smaller channels are more frequently designated as drains. Strictly speaking, however, the term *drain* is used to express the structure which carries off the subsoil water, by which process the ground is made dry.

A system of sewerage, therefore, presupposes the existence of decomposing and decomposable materials, or sanitary filth, — a term which, in its broad sense, is made to include, besides the contents of sewers and drains, those of pig-stys, manure heaps, compost piles, privies, cesspools, etc; or, as Dr. Simon says, "such as eminently the presence of putrescent matter, solid and fluid, causing nuisance by its effluvia and soakage." The emanation from this decomposition in the presence of water and in the absence of light, particularly that which is always present in sewers, from which it derives its name, is called, though erroneously, "sewer-gas."

As much confusion exists, especially in the mind of the layman (if I may use the expression), regarding the precise meaning of the term *sewer-gas*, and the relations which it bears to certain diseases, it will be necessary to dwell a little more fully upon this topic. The difficulty, I think, arises from the disposition to look upon this gas as one of the distinct gases, like oxygen, nitrogen, etc. As such, however, it does not exist; but there is a separate and peculiar emanation given off from organic matters in a state of fermentation and de-

cay, which is composed of the following-named gases: carbureted hydrogen, carbonic acid, oxide of carbon, sulphureted hydrogen, ammonium, nitrogen, etc., etc. Of these, carbureted hydrogen is found in the proportion of 72.88 in one hundred parts. These constituents are dangerous, however, only as they produce their chemical effects upon the system; causing, when diluted, headache and discomfort, and, in those habitually exposed to them, a vaguely depressed state of health, or, when sufficiently concentrated, instant death. But, as dangerous as these chemical poisons are, more deadly still are those other agents, given off from filth or decomposition, which are known as contagia, morbific ferments, organisms, microbes, bacteria, or germs. Their name is legion, but they all mean the same thing; they mean matters which, according to Dr. Simon, are "not gaseous, but, as far as we know, seem to have their essence, or an inseparable part of it, in certain solid elements, which the microscope discovers in them; in living organisms, which in their largest sizes are but very minute microscopical objects, and at their least sizes are unseen even with the miscroscope."

These organisms, in virtue of their vitality, are indefinitely self-multiplying within their respective spheres, and hence, "in contrast with common poisons, can develop indefinitely large subsequent effects from the initial doses, which are indefinitely small. Of these ferments or germs, the putrefactive, of course, are always present where putrefaction is going on, as in decaying animal matter; while others, though certainly not essential to all such putridity, are very apt, and some of them very certain, to be found in our ordinary refuse." In

view, therefore, of the composite nature of sewer-gas, which consists, as has been shown, of various gases and living organisms, the term seems to be a misnomer. It would be more properly styled an effluvium.

"As it is through the agency of these *morbific ferments* or *contagia*," Dr. Simon continues, "that the zymotic or fermentative diseases are produced by filth, it is very important that they should not be confounded with the fetid gases of organic decomposition." And just here is one great source of danger, since so many householders think that, when they have used agents to destroy bad odors, they have likewise taken away the power of disease production. There is nothing more fallacious than this, because, although we cannot prove that disease ferments, even if they could be isolated, are odorous, yet it is very certain that in doses sufficient to produce death they are "infinitely out the reach of even the most delicate sense of smell, and that, therefore, this sense is unable, except indirectly and insufficiently, to sound a warning to us in sometimes the most serious dangers from morbid infection."

With the manner in which filth produces certain diseases, or with the germ theory of disease, as it is usually expressed, a lecture of this kind has but little to do, particularly as there exists, even at the present day, some difference of opinion among scientists in regard to it. All that it is necessary for us to know is, that most of the leading pathologists now believe that particular diseases, such as cholera, typhoid fever, diphtheria, etc., do not, as was formerly thought, spring into existence spontaneously, or *de novo*, from filth, that is, that filth alone, communicating the elements of

decomposition, is not sufficient to produce them. On the contrary, it is declared that decomposition simply increases a tendency to the production of these affections, by furnishing a *nidus* or resting-place, — a favorable soil in which the particular organisms of disease multiply and develop, and without which such organisms become, as a rule, inert and inoperative. In short, the theory of to-day, and one which is supported by Pasteur, Tyndall, Koch, and Virchow, is that all diseases, such as cholera, typhoid fever, diphtheria, etc., which become epidemic, are produced each by its own particular germ, poison or seed (if you prefer the term), which is infinitesimal in its size, capable of retaining its vitality for an indefinite period, and which can be borne long distances without losing its power of springing into active existence, when once it meets an appropriate soil. When this seed or germ is introduced into the body, it will again produce its own disease, unless, in the meantime, it has come in contact with some agent capable of destroying its power of reproduction.

For a practical understanding of our subject, however, it makes but little difference whether filth directly or indirectly produces disease, since we know for a certainty, that unsanitary conditions do bear an accurate relation to a particular class of affections, and that they inevitably increase the mortality rate of every community in which they exist; whereas, on the contrary, the removal of such conditions invariably leads to an improvement in health, to a diminution of disease, and to a decrease in the death-rate. At the present day we never witness such wide-spread and fatal epidemics as occurred in past centuries; we never have to record, in

civilized countries, at least, such fearful destruction as visited Basle in the fourteenth century, when forty-one thousand deaths occurred in one epidemic of the plague, — a disease which at about the same time carried off three quarters of the entire population of Venice, — nor such as took place in 1517, when diphtheria — an affection which was accurately described by Hippocrates as early as 460 B.C. — carried off in the former city two thousand persons.

Two hundred years ago the death-rate of London was eighty in a thousand, while now it is but twenty "in spite of the great growth of towns and the great crowding of her population." England in twenty-two years of continuous wars lost seventy-nine thousand lives; in one year of cholera, one hundred and forty-four thousand, eight hundred and sixty.

In Great Britain, the deaths occurring in 1842 from typhoid fever alone — a preventable disease — outnumbered the losses sustained by the allied armies at the battle of Waterloo. Compare Pekin in China, without any of the modern sanitary systems, with a death-rate of fifty in a thousand, with London, where science, supported by intelligent and practical coöperation, has succeeded in reducing the death-rate to but twenty in a thousand. Sanitation has lowered the death-rate in Croydon from twenty-five to sixteen per thousand; and when the sanitary works are completed, it is expected it will be reduced to ten.

Having indicated to you in a general way what the dangers of filth are, and how great the decrease in mortality its removal produces, let us borrow a leaf from the records of medical experience, and learn what

particular diseases are most frequently produced by the existence and non-removal of organic decomposition. There is one large class, viz., the zymotic, fermentative, or infectious, most of which, if not all, seemingly bear such an intimate relation to "filth" that they are by most observers termed *filth* or *preventable diseases.* Of this class, those affections which may be designated as diarrhœal stand out preëminently in their close and intimate relations to uncleanliness. Typhoid fever is looked upon as the great type of interic disorders, and as the representative of the so-called *filth-diseases*, — the evidence, as you are all probably aware, being conclusive that it is caused or favored by the presence of organic decomposition. It is gratifying for us to reflect that in Massachusetts the mortality rate from this disease, in 1883, was 27 per cent less per ten thousand than that for the previous twenty-six years, and indicated a proportionate decrease of 21.9 per cent, as compared with the average for the previous fifteen years, — a result which is due to a better understanding of sanitary laws, and to a more rigid enforcement of them.

No doubt can exist that cholera and yellow fever can be spread, and that to an alarming extent, by unhygienic conditions, as is proved by the course of these diseases whenever they occur. You have not forgotten the history of the cholera epidemic in France and Italy last year, nor that of yellow fever in this country in 1878; how these fearful scourges fastened upon and rioted in the strongholds of filth, — the former in Marseilles and Toulon, La Spezia and Naples, and the latter in New Orleans, and other Southern cities.

Diphtheria also in some manner seems to be associated with unsanitary surroundings, and is always most fatal in those localities in which the sanitary condition is bad, particularly in respect to drainage, ventilation, and cleanliness. In this connection the following cases are instructive: Two boys lost their ball down a catch-basin in the street. In their attempts to regain it they inserted their heads into the hole, and remained in this position for some time. In a few days they were both attacked with diphtheria. A few years ago an epidemic of this disease broke out in a large tenement in a neighboring city. Upon an examination being made, a broken box-drain was found under the building, from which sewage had escaped. A proper drain was substituted, and no more cases occurred.

Scarlet fever is another disease, which, although it cannot be said to be purely a "filth disease," yet it certainly does co-exist very often with unsanitary surroundings, and its prevalence and mortality are lessened by attention to hygienic laws.

Consumption too may be fairly, I think, added to the list; for, whether we look upon the ninety-five thousand deaths, which occurred in the United States from this affection in 1880, as due to an epidemic, or whether the theory of Koch, that it is communicable by contagion is true or not, it is a fact that the construction of sanitary works certainly lowers its rate of mortality.

Apart from the diseases which have been mentioned,—and there are others besides,—persons who live amidst unsanitary surroundings, instead of being attacked with a well marked disorder, are liable to suffer from languor,

loss of appetite, colic, and prostration. Dr. Parkes says, "When sewer-gas penetrates into houses, and particularly into bed-rooms, it certainly causes a greatly impaired state of health, especially in children. They lose their appetite, become pale and languid, and suffer from diarrhœa; older persons suffer from headache, malaise, and prostration; there is often some degree of anæmia, and it is clear that the process of aeration of the blood is not perfectly carried on."

It may be very properly asked, as it very often is, why, if filth produces disease, it does not in every instance; for filth certainly exists much more frequently than does its offspring, — disease.

It is a fact, however, well known to physicians, that, of two persons exposed to a disease under similar circumstances, one will be attacked by it, while the other will escape. Constitution, peculiarities of temperament, and the state of the system at the time exert a powerful influence in determining any disease. This difference of susceptibility is observed in members even of the same family, not only in contracting disease, but in its fatality.

Moreover, the same person, owing to a different state of health at different times, may be stricken with a disorder, from which at another time he may escape. It is a well-established fact, that, in our waking moments, when the system is active and vigorous, we may be exposed with impunity to baneful influences, which in sleep may make an impression upon us. This is proved conclusively by experiences in malarious districts.

In the case of an epidemic of typhoid fever, which broke out among some boys, who were watching the

process of cleaning a drain in Clapham, England, the boys only were attacked, while the workmen escaped. Long exposure to unsanitary conditions may beget a tolerance of them; or, what is more likely, the influence of these conditions is so gradual, that the transition from health to sickness is not noticed.

Before leaving this part of the subject, in order that there may be no misapprehension of it, I beg you to consider that, in asserting that a definite relation exists between filth and the zymotic diseases, I do not mean to affirm that in every individual case we must look to unsanitary conditions, as the only cause which exists for their production. Many of these diseases are contagious, some of them remarkably so; and, like a conflagration, when once they have broken out, they may, by their contagious nature, be indefinitely spread.

Recognizing the intimate relation which is now supposed to exist between certain diseases and "filth," the next practical enquiry, having for its object the extermination of preventable diseases, which arises, is, how filth or the germs of disease are carried into the system, to produce there a morbid condition. This may be accomplished, as may be inferred by what has been said, through two channels, viz., the stomach or the lungs, — that is, we may either drink or eat it, or we may inhale it with the air we breathe. In the former case it is liquid or solid filth, and in the latter a gaseous one.

Of the water usually supplied to large cities, which, unless contaminated by accidental causes or by defective plumbing inside the house, is generally pure, but little need be said. But we are chiefly interested in the re-

maining source of supply, viz. from wells, which are now used to a limited degree even in cities. The reason why well-water is so frequently bad and unwholesome, is because sink-drains, badly-made house-drains, cesspools, etc., not unseldom empty their foul contents into them by percolation through the soil, particularly if it is a porous one, and has an underlying structure of clay or rock, which forms an excellent bed upon which liquids can flow. A frequent source of contamination of well-water in the country is by the kitchen slops, containing, as they do, elements of decomposition, which are thrown out upon the ground, and which, in course of time, as the custom is kept up, must pollute the wells by saturation of the soil. The most frequent causes of pollution, however, are from cesspools, which are seldom, if ever, made tight, and from the ordinary vault, which, of all filth influences which prevail against human life, operates to far the largest extent.

So easy is this pollution of water even upon level ground, that it is estimated that, whenever dwellings are situated within one hundred feet of each other, there is danger that the wells may become contaminated through some of the agencies which have been already mentioned. Of course the danger is infinitely increased, if the wells and the sources of pollution are placed more closely together. But filth has been known to leach through the soil to a greater distance than one hundred feet. Easie mentions a case, in which the contents of a cesspool poisoned a well two hundred feet distant.

If this will occur when the well and the "filth" source are upon the same level, how much more readily

will contamination take place, if the well is on a lower plane. The following striking case reported by Mr. Child, Health Officer for a portion of Oxfordshire, England, illustrates this principle: "In consequence of the escape of the contents of a barrel of petroleum, which had been buried in an orchard, a circuit of wells sixty feet below and nine hundred feet distant became so affected, that the occupants of fifteen houses, containing eighty-two inhabitants, were for ten days unable to use the water for cooking or drinking. The cattle of one of the proprietors, moreover, refused to drink at their accustomed spring." Had this soakage been sewage instead of petroleum, whose presence would not probably have been detected, who can doubt that the result might have been wholesale water-poisoning, followed by an outbreak of typhoid fever?

The intimate relation which exists between many diseases and well-water has been abundantly proven by experience. A few examples of this truth will be sufficient. In 1879 a person was attacked with typhoid fever in Fairhaven, Mass. His discharges, without disinfection, were thrown into the privy vault, the filth from which leached into the well one hundred feet distant. In consequence, eight members of the family contracted the fever within twelve days of each other. The direct communication between the well and the privy was proven conclusively by a salty taste, which was imparted to the water by a quantity of salt thrown into the vault.

In the cholera epidemic, which occurred in London in 1866, the mortality in the East End, which was supplied with water from a reservoir, "which was little

better than an open sewer receptacle," was from sixty-three to one hundred and eleven in ten thousand; while in other portions of the city, which were supplied with pure water, the mortality was only from two to twelve in ten thousand.

If the pollution of our drinking-water could always be made manifest by a disagreeable odor or an unpleasant taste, the danger to health would be infinitely less; for under these circumstances most persons would discontinue their contaminated supply. But, unfortunately, the dangerous character of these waters is often indicated neither by the odor nor taste of impurities. The fact that a water is clear and palatable is no proof whatsoever of its purity, since these conditions have been markedly present in some waters most shockingly polluted with sewage, as indicated by chemical and microscopical examinations. Some of the most unwholesome waters are especially bright, sparkling, and refreshing; but the chemical process, which has made them so, may have had no effect upon the germs of disease which they contain, and which have been known to produce the most disastrous results.

The water of the Aldgate Pump in London was always noted for its purity and its "very pleasant, cool, and sparkling taste"; so much so, that persons resorted to it from far and wide on account of its supposed medicinal properties. And yet, upon its analysis by Prof. Wanklyn, it was found that its refreshing character was due to its impregnation with the salts of decomposing sewage, which had found their way into the well.

The dangers, arising from the use of polluted water,

are still further increased by its ability to affect other fluids with which it is brought into contact. A number of cases of typhoid fever have been caused, both in this country and in England, by milk contaminated either by admixture with contaminated water, or by the dairy utensils and milk cans having been washed in it.

In regard to the evil effects which follow the use of impure ice, I simply mention the subject to call your attention to the fact that, while some organic impurities and disease germs may be distroyed by the action of cold, yet there are many others which are active chiefly during cold weather, and others still, which seem to remain latent at such times, only to be revived again under the influence of heat.

Although a chemical analysis may fail in certain cases to detect the poisonous character of a water, since neither chemistry nor the microscope have as yet been able to identify the *materies morbi* with any degree of certainty, yet the following test of Heisch's for sewage or decomposable organic matters will be found very reliable: "Fill a clean pint-bottle three-fourths full with the water to be tested, and dissolve in it half a teaspoonful of the purest sugar (loaf or granulated will answer); cork the bottle, and place it in a warm place for two days. If in twenty-four or forty-eight hours the water becomes cloudy or milky, it is unfit for domestic use. If, however, it remains perfectly clear, it is probably safe to use."

As dangerous, however, as polluted water is when taken into the stomach, more injurious still is the inhalation of air contaminated by the products or gases of decomposition, since we drink but a few pints of

water in twenty-four hours, while in the same period of time we inhale one or two thousand gallons of air, which through the medium of the lungs are taken directly into the blood. In fact, this is the only channel through which the germs of certain diseases are ever carried into the system.

A single example, taken from the many with which the literature of the subject is filled, will suffice to illustrate this principle. An epidemic of typhoid fever broke out in the Boys' School attached to Colchester Union, in England. The boys, who were first attacked and who suffered the most severely, were those who occupied desks which were placed in a direct line between a passage, in which there was an untrapped drain, and the fire. The natural tendency of sewer-gas to seek the warmest air caused it to pass over these desks, with the above result.

Enough has been said, however, perhaps more than enough, to clearly indicate to you the grave importance which exists for strict attention to the sanitary condition of our surroundings, particularly when the well-being of those of tender years, who, on account of their more delicate organizations, are more highly susceptible to morbid influences, are to be considered.

I have now explained to you what is meant by "filth," how it operates, its relation to disease, and the manner in which it is introduced into the system. There remains for us to consider the best methods for rendering this filth, which is always present, as innocuous as possible; and in doing so, I shall confine myself to the subjects of sewerage, house drainage, and house plumbing.

Starting with the sewers, we must presuppose the existence of a copious water supply and a scientifically planned water system, without which all drainage would be worse than useless. For the object of all sewerage is to carry off organic matter as rapidly and as continuously as possible, in order that, by a speedy removal of it, there shall be no opportunity for it to stagnate, and by its decomposition to give off noxious vapors. This can only be accomplished by means of water. To clearly understand this principle, it is necessary for you to remember that most materials discharged into the sewers are not, at the time of this discharge, in a state of decomposition, but that it is only under the combined influence of dampness, darkness, and non-ventilation that putrefaction is produced. Hence the rule has been established that sewage must be carried off entirely within two or three days, since before this time, though offensive, it is not by itself dangerous.

This, then, being the object of a good sewerage system, — viz., to carry off rapidly all decomposable materials, — it follows that the size of the sewers must be proportionate to the amount of sewage which is to pass through them, as well as to that of the rainfall. The one great mistake, which is so often committed, is in building sewers as well as drains altogether too large. For, although they should always be constructed so as to meet every possible requirement of the future, yet, if they are built to do more than this, they are defective. As it is a well-known fact that a stream of water will run more rapidly through a narrow channel than through a wide one, so sewage will be more quickly and effectually carried off by a small sewer — provided, of course,

that it is large enough for its work — than by one of great size, in which, owing to the sluggishness of its flow, its contents would soon become ponded and deposited, and the sides of the conduit remain unscoured.

Catch-basins, which, as you all know, are receptacles placed in the course of the gutters, and connected with the sewers in order to carry off the surface water, demand but a passing notice. If they give out a bad odor, it is either because there is some defect in the sewer, which allows the filth to become stagnant, or the water-seal in the basin has become broken (usually by the water not being renewed after cleaning), or the sewers are not properly ventilated.

This reference to the proper ventilation of sewers brings us to one of the most important underlying principles of a sewerage or drainage system. That sewers and drains should be thoroughly ventilated is, at the present day, no longer a question. Easie says, in his work on "Healthy Homes," that all theories of drainage, which fail to inculcate the absolute necessity of ample ventilation of sewers and drains, are worse than useless, — they are even dangerous.

In Croydon, England, which possesses one of the most perfect systems of sewerage in the world, typhoid fever, which occurred periodically, was formerly very frequent, and increased in one year the death-rate from 18.13 to 28.57 per thousand. Diseases, which were formerly confined to the lower portions of the town, were carried by the sewers to the upper portions. *After the sewers had been thoroughly ventilated*, there was no further outbreak of typhoid fever, although the population had been doubled; and the death-rate

now seldom rises to 16 per thousand, "a standard of health unparalleled in the history of sanitary science by a district having so large a population."

The necessity for this ventilation arises from the great lightness and diffusibility of sewer-gas, which in consequence seeks the highest outlet of escape, unless other vents are provided for it; and also from the compression and expansion of the air within the sewer.

This latter result is caused first by a sudden influx of water into it, either from a rainstorm or from the usual waste of a house. If the amount of water, thus admitted, is sufficient to fill the sewer three-fourths full, where it had been previously running only one-half full, the air, which originally had occupied the remaining half of the sewer, must be compressed into one-quarter of the sewer, which would increase the pressure upon the air by an amount equal to a column of water thirty-four feet in height. Of necessity this pressure will be relieved by an escape of the air through proper ventilators if they exist; otherwise through the various openings into our houses, unless these openings have been protected more thoroughly than is generally the case.

Compression of the sewer-gas is also caused by the temperature of the sewer being raised, either by the objectionable practice of letting waste steam escape into it, or by the discharge into it of hot water from factories, or from the wash-stands, bath-tubs, sinks, etc., of dwellings.

The amount of pressure, which is produced by an elevation of temperature from 50° to 150° Fahr., is equal to seventeen and five-tenths pounds to the square

inch, or to a column of water forty and seven-tenths feet high, — an increase of nearly three pounds to the square inch, or six and seven-tenths feet head of water, over the original atmospheric pressure. This additional force but few traps can resist, and consequently ventilation becomes a necessity.

When the volume of water in the sewers is again reduced, or a condensation of air in them has been caused by a lowering of their temperature by the admission of cold water, or by cooling after the hot water has passed off, a vacuum is produced, which causes atmospheric air at the rate of one thousand three hundred and thirty feet per second to be drawn in; and this alternate exhalation and inhalation of air is what constitutes the proper ventilation of sewers.

Other forces likewise contribute to the ebb and flow of air in the sewers, such as barometric changes, wind blowing over the tops of the ventilators, and the law of diffusion of gases.

The usual method of ventilating the sewers is through the man-holes in the centre of the street, which are supplied with perforated covers for the purpose. It was at one time proposed (and some cities adopted the plan) to ventilate the sewers and drains by means of the rain-water pipes, which carry off the water from the eaves troughs. But this method has been found not only impracticable but dangerous; since, just when ventilation is most needed, viz., in heavy rainfalls, when the sewer-gas is greatly compressed by the sewers running nearly full of water, these water pipes are likewise full, and consequently are entirely inoperative as ventilators for the passage upwards of the gases from below.

That these pipes cannot be depended upon solely to furnish ventilation to main sewers, is also evident from the fact that, when the sewers are running very full of water, the entrances into them of house-drains are generally below the level of the water, and consequently the air in the sewer becomes compressed to such an extent, that it soon acquires enough power to force a passage through channels the least expected. For this reason, ventilation of sewers, by any ventilator connected with a house-drain leading into the sewer, is at many times ineffectual; and street ventilators must therefore be provided for the purpose. Then, too, the rain-water pipes are objectionable, on account of their opening at the eaves of the house, which may be in such close proximity to windows in the same house or in that of a neighbor's, that the gas carried off by them will find its way into the dwelling.

Besides, they are very likely to leak, either in their joints or seams, thus allowing any gas which they may contain to effect its entrance through the windows. Moreover, in winter, when the introduction of unhealthy emanations into our houses is particularly dangerous (since but little air can be admitted, in our climate, at least, to dilute them), the conductors are usually choked with ice, and consequently useless for the purposes of sewer ventilation.

That these pipes used for this purpose are dangerous to health, has been abundantly proved by many instances. The drain of the U. S. Marine Hospital at Chelsea, Mass., was formerly ventilated by means of the water pipes leading from the eaves trough; during one winter the water in it froze, and as a consequence

the pipe burst in the neighborhood of a sleeping apartment. Two brothers of the surgeon-in-charge, who occupied this room in the following summer, died of typhoid fever, — a result which was attributed to the escape of sewer-gas through the leak in the pipe into their sleeping-apartment.

In Croydon, previous to 1860, the sewers had been ventilated by small pipes, particularly at their heads. In this year, however, a law was passed, compelling ventilation by means of water pipes; whereupon the death-rate commenced to steadily increase from 16.63 in 1861 to 21.26 in 1865. Upon the repeal of the law, and the ventilation of the sewers by openings in the streets, the death-rate commenced immediately to fall from 21.26 to 16.6 in 1869.

With the shape, material, and outlet of sewers we have nothing to do, although these problems of construction are of great importance to engineers.

Leaving now the sewers, we come directly to the house drains, or the connecting link between the plumbing of the house and the main sewerage system.

These drains are of practical importance to us, since any imperfections, which may exist in them, tend to conserve the filth in close proximity to our dwellings.

The best material for house drains is undoubtedly a vitrified pipe, well burned and smoothly glazed, unless when the ground is "made." In such cases, on account of the liability of the drain to settle and break, when made of a perishable substance, iron should be used; as it also should be when the drain has to run in close proximity to the well or other source of water supply. It is important, however, that the vitrified

pipe should not be employed beyond a point which is well outside the foundation walls of the house. At this point iron should be substituted.

Great care must be taken that the joints of the pipes are tight, and not left open from the mistaken idea that such openings can be used for carrying off the subsoil water. This precaution, which is too often neglected by careless or ignorant workmen, is particularly important at the connection between the internal and external systems; since the filth which must be inevitably poured out, where the joints are leaky, will thus accumulate and saturate the soil in close proximity to the dwelling. Moreover, sewage, which has lost some of its liquid components, has been deprived of the force of its flush, and hence the solid portion remains in the pipes, to decompose and fill them with noxious gases.

One of the most common causes of obstruction in the house drain arises from the grease, which is usually, but which should not be, poured down the kitchen sink, and which, when hot, is fluid, but when cold becomes solid. Drains thirty to fifty feet in length have been entirely closed from this cause. Hence some provision to arrest this material becomes necessary, which is ordinarily furnished by a receptacle, called a grease trap. If our servants could be depended upon to save the two hundred pounds of fluid fat, which are in some households annually wasted by discharge into the drains, grease traps would be uncalled for. Even as it is, some sanitarians advise against them, preferring to depend upon the ordinary trap under the kitchen sink, provided with an opening closed by a stopper, for the arrest and removal of the grease. For many reasons this plan seems to be

defective, and hence it would be better, wherever it is possible, to provide a separate grease trap outside the house in the line of the drain. This is very necessary for all places where extensive cooking is carried on. It should be perfectly water-tight, frequently cleaned out, and thoroughly ventilated by a grating in its cover. In no case, however, should the grease trap be located inside a dwelling, since it will in most instances become a cesspool, and give out the vapors of decomposition directly into the house, unless more carefully and frequently cleaned out than is usually the custom.

Before proceeding to the next principle involved in a system of drainage, let us pause a moment to condemn the practice, so commonly in vogue in rural or suburban districts, of throwing out slop waters from the house upon the ground, or running them in open gutters to the nearest pond or brook. It is needless to add that such practices are entirely wrong, since, by the continued soakings of the ground, the water supply is liable to become fouled and the atmosphere polluted. For the same reason it is wrong to lead the waste pipe from the kitchen sink in such a way, that the waste matters shall flow through it upon the ground.

Another custom, which is very common in country districts unprovided with a sewerage system, is that of storing the filth of the house in cesspools. As ordinarily built, these receptacles furnish the worst possible method for the disposal of the sewage, since they are very frequently located close to the house, sometimes directly under it; and, being in most cases mere pits dug in the ground, they allow the fluids which they contain to soak away into the subsoil, while the solids remain

in them to decompose and generate foul vapors. They thus become centres of filth of the worst kind, polluting the water which is drunk, and poisoning the air which is breathed.

If, on the contrary, the cesspool is built perfectly tight, so that its liquid contents cannot leach into the soil; if it is located at a safe distance from the house, thoroughly ventilated, and frequently cleaned out and disinfected; if it is small and built in two compartments, — one for the fluids and the other for the solids, — it then becomes reduced to its minimum of danger.

Resuming now our progress along the drain towards the house, we shall, or rather we ought to find, a bend or depression in the pipe, which, owing to this depression, holds water. This device is called a *trap*, and is an example of a very important factor in sanitary drainage. A trap is an obstacle, usually of water, placed in the line of drains and plumbing fixtures, to prevent, as far as possible, the free passage of sewer-gas into the house.

That some barrier to the otherwise inevitable entrance of this gas into our dwellings must be provided, you can readily understand, if you will bear in mind the nature of these vapors, and the forces which are continually at work in the sewers to produce a compression of them. As necessary, however, as traps are, they cannot be said to be of unmixed good, since they defeat to a certain extent the law of perfect drainage, viz., that filth must be carried off rapidly and without unnecessary obstruction Hence every trap, offering as it does to a certain extent an obstacle to a free flow of water, and tending therefore to the production of deposits with their consequent decomposition, must be regarded as an

evil, although a necessary one. But traps are made more of an evil than they need to be, by the very common and objectionable custom of not flushing them thoroughly with clean water, after the sewage has passed through them. No matter where the waste water comes from, the last of it will remain in the trap to give off offensive odors, unless for a few minutes clean water is allowed to run into the fixture, and thence through the discharge pipe into the trap. This latter precaution, therefore, should never be omitted.

Such an infinite variety of traps has been invented, that, in selecting the best form, one is very apt to become confused. As an aid in the selection the following principle, expressed by Mr. Hellyer, will be found useful: "No sanitary fitting, waste pipe, soil pipe, or drain, should be trapped in a way that will not admit of the whole of the water being entirely changed every time a good flush of water is sent through them." In accordance with this excellent rule it has always seemed to me that the so-called mechanical traps — that is, those which depend upon some device besides water to effect a seal — are, with but few exceptions, hygienically unpractical, since they offer greater obstacles than the simple forms to the free flow of sewage, and are more liable to become foul by the deposit of filth in their angles and recesses.

Probably the best trap for house drains and for general use is that which, from its shape, is styled a syphon or S trap, and which retains in it enough water to form an effective seal. It is self-cleansing; it is the simplest, the least liable to derangement, and the most economical, — thus fulfilling as nearly as possible, under certain

restrictions to be mentioned hereafter, all the requirements of a sanitary fixture.

The place where a trap will be of the greatest service is either just inside or outside the house wall, in the main house drain, *after it has received all of its connections;* since, without this barrier, the pressure of the gas would, in all probability, force some of the smaller and weaker traps above, in the plumbing of the house. Dr. Parkes says: "The rule in fact should be, that the union of any pipe with the outside drain should be broken both by water and ventilation. The simple plan of disconnection, if properly done, would insure persons against the otherwise certain danger of sewer-air entering the house. Houses, which have been for years a nuisance from persistent smells, have been purified and become healthy by this means."

A neglect of this simple precaution of trapping outside of the house was said, by the leading physicians in England, to have been the cause of the dangerous attack of typhoid fever, from which the Prince of Wales nearly lost his life at Lownesborough Lodge some years ago.

When this trap is located outside of the house, especially in all land where there is danger of settling, it is advisable to place around it a man-hole, in order that the drain may be easily inspected, and an opportunity afforded of clearing away any obstruction which may have occurred at this point. It is also advisable to run into this trap the rain-water conductor, to insure a good flushing at each rain-fall.

As waste pipes always contain more or less foul air, which should be diluted and rendered as harmless as

possible, a current of pure air must be admitted into them. This is accomplished by introducing at *a point on the house side of the trap* an air-inlet pipe, the full size of the drain pipe, and extending a foot or more above the ground. Through this pipe a current of air will now almost continually pass towards the warmer atmosphere of the house, except when a discharge takes place through the soil pipe. At such times the current of air may be for a short period reversed, and forced out of the vent pipe. As long, however, as such inlet is judiciously located, removed from windows, piazzas, or the cold-air box of the heating apparatus, a reversed current is not productive of harm.

Several modifications of this plan have been devised, but all are based upon the above principle.

If the grounds about the house are restricted in the direction of the sewer, this vent pipe may be carried to a point of the drain inside the house, leaving room outside for the rain-water spout to discharge into the trap. But, as has been said before, in no case should this spout be allowed to serve as the sole vent.

A house drain, which has been properly constructed, does not require a catch basin; but if, from lack of a sufficient fall or from being too large, or from any other cause, the flow through it is sluggish and stagnant, then an opening in the line of the drain is advisable, through which it can be cleansed by wires or scoops, or by flushing.

Having now inspected the drain as far as the house, let us follow it into the cellar, — a portion of the dwelling which is too often found, both in the country and in the city, to be in a grossly unsanitary condition. If

the drainage system has been properly constructed, we shall see in the cellar the continuation of the house drain, now made of iron pipe (this material is carried well outside the foundation walls), painted white to show any traces of leakage, and either running along the foundation wall or suspended from the ceiling, or, as some advocate, supported on brick piers built from the floor.

In cases where it can be so arranged, it is a better plan not to allow the drain to traverse the house, but, following the sanitary rule, to conduct it outside as soon as practicable. With the drain constructed in the manner described above, it is brought into sight for inspection,—it being a well-recognized principle in modern house drainage, that as little as possible of this system should be concealed from view.

In some houses, which contain plumbing fixtures in the cellar, the drain, made of earthen ware, is found buried beneath the floor. This is wrong, even when the vitrified pipes are used, since, as Mr. Gerhard says, they often crack through settlement, and have leaky joints,—the ground under the cellar thereby becoming saturated with sewage. Besides, it is impossible to properly connect an upright soil pipe to an earthen drain, for, no matter how well the joint between them is cemented, a settlement of the soil pipe will break off the hub of the earthen pipe, or the latter will settle away from the former, leaving an opening, through which the filth will escape. Such accidents are exceedingly dangerous to health, as is instanced by the following illustration:—

The family of a gentleman, living in one of our large

cities, was stricken with diphtheria. Careful inspection disclosed a small crack in his cellar wall, while further investigation revealed a missed connection between an upright soil pipe and an earthen drain in the house of his neighbor, whose family was also suffering from diphtheria. The filthy contents of the pipe were pouring out just at a point where the gas and disease germs could pass, without check, through the crack in his wall.

If the drain must be laid beneath the cellar floor, it should be of heavy iron, and be made accessible, so that any obstructions which may occur in it can be readily removed.

In advocating that the drain pipe should be run across the cellar in plain view, I am reminded by the defects in some houses to suggest, that it should not be located in close proximity to the cold-air box of the heating apparatus; since this box is very often leaky, owing to imperfect construction, and hence any flaw or leak in the drain pipe would cause the gases from it to be drawn into the furnace, to be distributed throughout the rooms above.

It would seem almost absurd to remind you, that a refrigerator or an ice-box should not be directly connected with the drain by a pipe, to carry off the water from the melted ice, were it not that it is a custom which is not at all uncommon. Such a sanitary mistake was supposed to have brought severe sickness and death into the family of one of our most prominent citizens, — the articles in the refrigerator being actually tainted by sewer emanations.

Having now hastily inspected the cellar, for time for-

bids any reference to the subsoil drainage of it, let us follow the course of the drain or, as it is now called, the soil pipe, upwards. We find it constructed of iron, usually four inches in diameter (it may be in small houses three and one-half inches, but never larger than four inches), jointed in lengths, and receiving waste branches from the various fixtures, such as bath and laundry tubs (the latter, however, sometimes connect directly with the drain), wash-stands, sinks, water closets, etc., — all of which constitute the internal drainage system of the house. This system is, as you can well believe, of vital importance, since by it the interior of our dwellings is brought into direct connection with the drains and sewers, from which sewer-gas will penetrate into our living rooms, unless the house drainage is scientifically and thoroughly constructed. How infrequently the proper attention is paid to this, even by those who ought to understand the system, the occurrence of death, due to errors of construction, and the necessity for controlling the plumbing of dwellings by ordinance sufficiently attest.

A former Lord Mayor of London, a gentleman well known for his researches into sanitary science, lost, some years ago, eight members of his family from diphtheria,— "a penalty I paid," he said, "for being a wealthy man, and having in my house all the modern conveniences, which, when too late, I discovered were defective."

Under such circumstances, what should be a blessing proves to be a curse, and hence it would be far better to return to the old system, by which, at least, the germs of disease could not so readily be introduced into our houses to poison its inmates. This is a matter which

concerns not alone those who are experts in all the details of house construction, but the householder also. Each individual is interested in it, independently of his neighbor and independently of the sewers, since no amount of skill nor care, in constructing these sewers, will relieve him of the necessity of using the same care and skill in building his house drains, particularly as these drains will often cause, by their faulty construction, more trouble than all the rest of the sewerage system.

One of the most common defects, found in the plumbing of the house, is the almost criminal carelessness with which the sections of the soil pipe are jointed, especially when these pipes are built into the wall, where any errors of construction can be effectually concealed. Such joints are often made with paper covered with sand, cheap mortar, putty, or red lead, which, it is needless to add, will not prevent the escape of the gases from the pipe into the house. It is just in connection with these defective joints, that the advantage of the peppermint test, which is undoubtedly familiar to you all, is seen. As valuable, however, as this test is in its proper sphere, it is a fallacy to rely upon it, as many seem to do, to detect all the errors and defects in the house drainage. If too much reliance is placed upon it, it will prove to be a very unreliable agent.

In order to carry out fully the principles of ventilation, the soil pipe should be extended above the roof not less than two feet, in order that its opening, which should never be obstructed by a hood nor return bend, may be well exposed to the air currents. This extension should be at least the full size of the pipe, to insure an upward current, and to prevent its end becoming closed by hoar frost.

Great care should be taken that these pipes do not terminate near windows, skylights, nor chimney tops, through either of which the escaping gas may be conducted into the apartments. For the same reason they should not open into chimneys, as some propose, although it is an excellent plan to lead them along a heated flue, in order to insure an upward draft through them.

The necessity, which exists for ventilating the system in this manner, is derived from the fact that gases are generated in the soil pipe and drain from the decomposing matters, which will inevitably coat their sides, and that consequently a ready method of escape must be provided for them. If this channel of outlet is not an open vent, such as the soil pipe extended above the roof, it will certainly be found through the branches of the soil pipe, extending to the various fixtures inside the house.

All these attempts, however, at establishing an air current will be futile, unless the pure-air inlet, which has already been described, is furnished at a point outside the house. Together with this inlet, the inner house drain and the soil pipe form a connecting system, resembling a syphon, through which there will be a free circulation of air, almost constantly in the direction of the warmer leg, — which leg, being inside the house, must be the soil pipe. Thus, with pure air steadily sweeping through the pipes in one direction, to dilute the foul air which they contain, and with water flowing in the opposite direction, to rapidly carry off the decomposable materials which are poured into them, we have brought to our aid two very efficient agents in rendering modern drainage as harmless as possible.

In this connection, it is proper to state that the air-inlet pipe is sometimes extended above the roof. This method, however, is open to the objection that the pressure of air would then be nearly equal in both legs of the syphon, and hence but little circulation of it obtained.

As clear as this principle of ventilation would seem to be, yet there are many houses in every large city, in which the soil pipes have no circulation of air through them, but stop at the trap of the highest water closet, or with a closed end in the attic. That evil may result from such unsanitary plumbing, the following case will demonstrate: The occurrence of sickness and death in a house, situated upon one of the most fashionable streets in New York, led to a careful inspection of its drainage system, when it was discovered that the soil pipe, which received the wastes from all the fixtures in the house, terminated in the third story, where it was plugged with an iron cap. Inserted through this cap was an inch pipe, which ran to the tank, from which the whole supply of water for drinking and cooking was derived. It was thus intended to act as a waste pipe for the overflow of the tank, but in reality it served as an escape for the poisonous gases from the soil pipe, which by its aid found an entrance into the water destined for domestic use.

We have now considered the proper method of ventilating the house drainage; viz., by extending the soil pipe above the roof, and providing an inlet for the admission of fresh air. The system is, however, incomplete, since we have no reason to expect that the sewer air will seek an outlet through the soil pipe, in prefer-

ence to the wastes which lead from the various fixtures. On the contrary, there is every probability that the gases will, on account of the warmer atmosphere of the rooms, be drawn into them through the different plumbing appliances with which they are furnished. Hence, some barrier must be placed in the line of all discharge pipes, which, by rendering it difficult for the foul air to pass, will cause it to escape through the unobstructed channel of the soil pipe. In other words, these discharge pipes must be trapped. The house drain has already been trapped, to prevent the escape inwards of the gas from the sewer, but in addition to this, each water closet, slop sink, wash bowl, bath tub, sink and set of laundry tubs should be provided with a reliable trap, placed as near to the fixture as possible.

In considering the best form of trap for fixtures, it is needless to enter into the details of the many varieties which have been placed upon the market. All that it is necessary to remember, in selecting a trap for such purposes, is that the best is one, which will allow the water in it "to be entirely changed every time a good flush of water is sent into it." Hence, for reasons which have already been stated, the S trap seems for general use inside the house to be again the most desirable.

Although the above rule applies to all traps, whether in a drain or under fixtures, yet it is particularly applicable to those for slop sinks, water closets and other fittings of a similar nature. In order that such fittings should be able to keep their traps in a proper sanitary condition, it is very necessary that they should receive their water supply for flushing from special tanks or

cisterns. This safeguard is too often neglected in school houses and public buildings, in so many of which the flush of water is supplied in a feeble stream, which even then is only turned on at certain periods. The great defect in the water supply for such fixtures is the dependence upon a branch from the main water pipe in the house, from which pipe the drinking-water and that used for cooking is drawn. This is highly objectionable, since the supply is sometimes cut off on account of repairs in the street or in the house pipes, or when water is drawn from a faucet down stairs, thus leaving the fixture for a time without proper means for flushing. Moreover, under such circumstances there is danger that the foul air, which is present in the interior of many closets, particularly the old-fashioned variety, will be sucked in by the vacuum produced in the pipe, and consequently contaminate the water.

The dangers from this source are by no means hypothetical, but have been proved by well authenticated facts. One, which is often quoted, is the instance of a severe epidemic of typhoid fever, which broke out a few years ago in Caius College, Cambridge (England), where the most thorough, and, as was thought, the most perfect system of water supply and drainage had been introduced. Upon investigation it was found that the drinking-water had been polluted in precisely the same manner, as has just been mentioned. The whole difficulty was caused by a valve, which guarded the outlet of the branch pipe, having been placed horizontally instead of vertically, to be influenced by gravity, and thus permitted the escape of foul vapors into the main water supply. This case is interesting also, as showing

from what trifling causes sometimes the most serious results will follow, and how careful workmen should be to perform their work in a proper manner.

The best material for water-closet traps is earthenware or porcelain, on account of its greater cleanliness. Such traps are always placed above the floor, which brings them into plain sight, and makes them easy of access.

While discussing the subject of traps, I cannot forego the opportunity of warning you against one variety, which has been extensively used for kitchen sinks. I refer to the so-called bell trap, which is worse than useless, since it contains far too little water to effect a seal, and cannot be kept clean. If it is provided with a strainer, as it usually is, this strainer soon gets choked with the refuse of the sink, and is consequently removed, thereby leaving a direct communication between the drain and the room in which the sink is located.

As valuable as traps are for the protection of dwellings against the entrance into them of sewer gas, their efficiency is somewhat impared by the fact that, under certain conditions, they may lose the water upon which they depend for a seal. This accident is likely to occur from the friction produced by a rush of water through them; from syphonage, whenever a sudden flow takes place down the soil pipe into which the wastes discharge, or from another fixture connected with the same waste pipe — a partial vacuum thus being formed — or by evaporation. The latter cause operates more frequently, when the water in the trap is not renewed by frequent use.

Moreover, traps may be forced by the compression of the air within the sewers, when no proper vents have

been provided for their escape, or their water may absorb gases, giving them off on the house side of the trap, and even germs of disease, when the water is violently agitated. It is a very common belief that no gas can be transmitted through the water of a trap. As a proof, however, of the facility with which this can be accomplished, it is only necessary to suspend a piece of litmus paper, saturated with a solution of sulphate of lead, over any unventilated, but trapped pipe, leading to a drain, and notice how quickly the paper will become blackened by the action of the gas. Dr. Fergus, of Glasgow, found that ammonia would pass through the water of a trap, which he had made from glass for the sake of experiment, and bleach litmus paper in fifteen minutes, and that sulphurous acid, sulphureted hydrogen, carbonic acid, hydrogen and chlorine would produce their chemical effects in from one to two hours.

For the reasons, which have just been described, mechanical traps were invented — most of which, however, on account of their complicated parts, and the difficulty of keeping them clean, are unserviceable. One of the best of them, in my estimation, is a modification of the so-called Bower trap, which, on account of its simplicity, may be used with advantage under wash bowls and other fixtures of a similar nature, from which the discharge of water is reasonably clean.

Most, if not all, of the dangers arising from traps, may be reduced to a minimum by a thorough ventilation of the sewerage and drainage systems, and by leading each discharge pipe separately into the soil pipe. This latter plan is not, however, always practical in

large buildings. In addition to these safeguards, very thorough protection against syphonage, back pressure and absorption of gases is afforded by attaching a vent pipe to the upper bend of each trap, and leading its open end through the roof to the outer air. These vents may be collected into one common branch, opening into the soil pipe *above the highest fixture.* An additional advantage, which these vents possess, is that they serve as a channel for the escape of the foul air which is generated in the waste pipes, and hence add very greatly to the completeness of the ventilation.

Objection has been raised to such vents by some writers, that they greatly increase the cost of plumbing, especially where the fixtures are scattered throughout the house; that they tend in some degree to increase the evaporation of water in the traps; and that they may become clogged by the splashings of soapy water. In view, therefore, of the difference of opinion which exists in regard to their necessity, it is suggested by Mr. Gerhard that a middle course be pursued, and that, where fixtures are located some distance from the soil pipe, into which they consequently discharge through a long waste pipe, it is positively necessary to provide those vents. If, however, the fittings are located quite near a vertical, *thoroughly ventilated* soil pipe, or a well ventilated horizontal pipe, they may be dispensed with, provided a non-syphoning trap is used.

In connection with this subject, there are several fixtures in almost every house, which demand particular consideration. The most important of these is the water closet, — a proper selection of which is rendered very difficult, on account of the many varieties which

are offered for sale. Without discussing the advantages or disadvantages of all of them, it will be sufficient to state generally that water closets are divided into two classes; viz., those which are provided with mechanical parts, and those which consist of a plain bowl, usually of earthenware, with the whole flushing machinery located in a special tank. To the former class belong the pan, valve, and plunger closets, and to the latter the hopper closet, which is again divided into the long and the short forms.

Of all the different varieties, the pan closet, which is the one most commonly used, is the worst. Tightly encased in wood-work, there can be no ventilation of the space under the seat; it usually receives its water supply directly from the main water pipe of the house; its bowl is with the greatest difficulty kept clean; its receiver, which is made of iron, and rough on its interior surface, soon becomes fouled by accumulated deposits, which the water flush cannot remove; while every time the pan is tilted the generated gases are forced into the room. Add to these defects, the facts that the trap will usually become coated with filth and give off foul vapors to increase the volume of those already collected in the receiver; that the various apertures outside the bowl furnish a direct communication between the interior of the wooden casing and the soil pipe; that the gearing, with which the closet is provided, is invariably loose and easily deranged; that the pan becomes quickly corroded by the action of the sewer-gas, thus depriving it of one of its seals, and we have the very quintescence of an unsanitary fixture.

The valve and the plunger closets, although somewhat

superior to the pan variety, become readily fouled, and their complicated machinery is very liable to get out of order.

The best closet is undoubtedly the hopper closet, on account of its extreme simplicity and the great force of its flush — the water being supplied through a large pipe leading to a special tank. Of the hopper variety the short one is the most desirable, since it presents less surface for fouling, and the trap is located in plain sight above the floor. Again, preference should be given to the modification of this closet, known as the "wash-out," which is made of earthenware, in one piece, and the basin so shaped that it holds water, and forms a trap against the escape of gases.

Whatever form is used, however, care should be taken that the closet is placed as far as possible from the living rooms; and, wherever located, strict attention should be given to the ventilation of the room in which it is situated, by a window opening from the top. This precaution is often almost entirely neglected, — the closet, particularly the servants', being tucked away in a dark, oftentimes damp, corner (the very soil in which disease germs retain their vitality), with no chance for the sewer gas, which emanates from it, to escape, excepting into the house. This defect is not uncommon in school houses.

The only remaining fixtures necessary to be mentioned are the wash bowls and bath tubs, which are so often improperly designed and constructed. Their wastes frequently lead directly into the soil pipe, with no trap to break the connection, or if trapped, it is only by running these wastes into the water-closet

trap below the water line. Further, the overflow pipes are often conducted into the discharge pipes of the fixtures beyond the trap, thus affording an easy passage for the escape of the gases into the apartment.

If it is certain that the sewers and drains have been properly constructed, and that the plumbing of the house is in a perfect condition, there can be no objection to placing a fixed wash-stand in a sleeping apartment; yet, with the doubt which must so often exist upon these points, it will be safer to depend upon the bowl and pitcher in this important room.

Whatever the fixture may be, — wash bowl, bath tub, water closet, etc., — the best modern plumbing leaves them all without any casing or covering. Pipes may not look quite so well as handsome cabinet work, but it is a sanitary measure to uncover them, since cleansing is thereby greatly facilitated, and everything is brought into plain sight for inspection.

In contemplating this whole subject, I wish to impress upon you that its importance cannot be over estimated, and that no matter from what standpoint we look upon it, — whether from a consideration of the evils arising from lack of sewerage, or from imperfections in a system already existing, — it demands the closest attention. The relation between filth, which improper sewerage creates, and disease has been abundantly proved by experience, — particularly in cities, where large masses of people are crowded together, and where, if an epidemic of any disease breaks out, it tends to run a more rapid and fatal course. This is especially true in the case of children, whose delicate organizations subject them, if not to a more ready inception of the

poisons of disease, yet certainly to more rapid deterioration of health, when they are exposed to unhealthy surroundings.

It is to aid you in detecting the defects in what may be either your master or your slave, according to its condition, that I have in this necessarily imperfect manner brought the subject of drainage before you. In remembering the details of it, I trust that you will also remember that eternal vigilance is the price of health, and that, having fitted your houses with perfect drainage and plumbing, it all needs looking after from time to time, just as much as any machinery or engineering structure. Recollect also that, although good plumbing is expensive, yet, to take the lowest view of it, sickness and death are more so still.

In bringing to your notice, however, what may be justly termed "filth in its relation to disease," it has been far from my intention to overdraw the picture, or to assert that our surroundings are in an altogether unsanitary condition. The records of mortality prove the contrary; but that this mortality can be still further decreased, I have not the slightest doubt, if individuals would but recognize what is meant by filth and the effects produced by it, and not delude themselves with the belief that, because their surroundings seem healthy; that, because their houses are provided with every modern luxury, no filth exists about them.

This assumption of cleanliness is often made by individuals, either through ignorance of the sources of filth, or from the natural reluctance, which every one

feels, to acknowledge even to himself, that his house or his premises are in an unsanitary condition. Possibly, however, with the best intentioned desire to detect a supposed sanitary error, it may be hastily assumed that no such error exists, because it may not have been immediately discovered. But, as has been already pointed out, because filth is not suspected, it does not prove that it does not exist: it may lurk in the drinking-water, which is not condemned, because it has neither an offensive odor nor an unpleasant taste, or because the microscope has failed to detect in it the germs of disease; or it may be present in the gases of decomposition, which are not recognized, because they may not give out a sickening smell. The source of filth may not be evident to the sight: it may not be the pig-sty, the manure or compost heap, the privy, the cesspool, or the slop water, from which the wind blows the emanations into the house; but it may be a pile of decaying potatoes, which, buried under the kindling-wood, has not been suspected, but which none the less surely caused an outbreak of typhoid fever in the house of a western physician; it may be the sudden filling of the sewer with rain water, which has compressed the sewer-gas through unguarded inlets into the sleeping room; it may be a leaking soil pipe in the wall, such as produced erysipelas in Middlesex Hospital; the cesspool gas, which has been conveyed by the cold-air box, through the furnace, to our living rooms; the minute defect in a water-closet valve being placed horizontally instead of vertically, such as caused the outbreak of typhoid fever in Caius College; it may be in the ice, such as caused

intestinal disorders at Rye Beach; in the milk, such as has produced so many outbreaks of typhoid fever in England; or it may be that the cause exists "in houses built on hills, in which the most skilful engineers and architects have exhausted, as they believed, the resources of modern science, from the sewer-gas which has ascended by its lightness through drains having a rapid fall."

Moreover, filth does not always operate where it stands. It may not be on the premises where disease has broken out: it may exist on those of a neighbor, in a broken soil pipe, which was supposed to have caused diphtheria to attack a wealthy family in New York; it may be that a neighbor's filth has leached into our well; that from his cesspool, his slop water or his defective drain, sewer-gas has escaped into our house; or it may be that the ventilation of the main sewer by rain-water spouts has produced disease, as it did so markedly in Croydon.

But filth may not advance upon us from the next lot: it may invade our houses from long distances off, to cause disease, as was the case last winter, when an epidemic of typhoid fever broke out in a Pennsylvania town, from the pollution of a stream at its head, several miles distant; or, when the same disease almost devastated certain portions of a town in Massachusetts, the germs being wafted from a school house in which an epidemic of it had occurred.

Country districts prove no exception to the rule. Because an epidemic breaks out in the country it is unwarrantable to assume that filth has nothing to do

with its causation, simply because it has occurred in the country. The sanitary condition of many rural districts is notoriously bad, and in them, therefore, epidemics often rage with great intensity and fatality. But it is because they are cursed by an entire lack of drainage, with slop waters, privies and cesspools polluting the ground, well water and springs, as well as the atmosphere; because the members of the household frequently occupy, as a living room, one upon the ground floor, in close proximity to the source of the gases which float in at the open window; or because the soil is damp, thereby producing malaria, consumption and diphtheria.

A great responsibility, therefore, rests with those, who hastily assume that no unsanitary condition exists, to cause the many diseases which are now recognized as in a measure preventable,—an assumption which too often induces a false sense of security, from which they may be roughly awakened by the presence of death. There has never been a time when physicians were more thoroughly convinced, that great care should be taken in pronouncing too hastily against the existence of a definite cause for certain diseases, since the opinion is growing, that filth prevails as an originator of sickness much more frequently than is even suspected.

Communities and individuals are easily aroused to the realization of these principles and of their own danger, in the presence of severe epidemics, but like the horrors of an Ashtabula railroad accident, or the City of Columbus marine disaster, the lessons to be learned from these outbreaks of disease are soon forgot-

ten. If this should occur at the present time — if we should consign to the dim memories of the past all recollection of our ability to stamp out certain diseases — we must be held accountable. Is it not better, therefore, to heed the hand-writing on the wall, and, by following the old Greek sanitarian's maxim of pure air, pure soil, and pure water, to prevent, as far as lies in our power, the possibility of threatened epidemics?

THE RELATION OF OUR PUBLIC SCHOOLS TO THE DISORDERS OF THE NERVOUS SYSTEM.

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A LIBERAL education in the sense in which the term was used when the Boston public school system was begun, is no longer possible. In the place of knowing everthing worth knowing in his day, as was said of Lord Bacon, the most highly educated man of the present time does not know the whole of his own profession. The occupations of mankind have become so enormously diversified that no school can fit its pupils directly for any considerable number of them; so that general training, rather than the acquirement of learning, has become more and more the purpose of our best systems of public education. Committing to memory page after page of an increasing variety of text-books, largely for the sake of brilliant competitive examinations, beside overtaxing the brain, has been proved to be, as a means of educating children, far inferior to methods by which the observation, reflection, and judgment are trained. When the youth of either sex leaves school to seek a place in the busy world, the question asked him or her is "What can you do, how well can you do it, and how will your strength hold

out?" not "What do you know, can you spell words that would puzzle a lexicographer, or do sums, as it is called, beyond the powers of a bank cashier?"

As a consequence, the courses of study which best develop the mind and best prepare the pupil for the duties of life, and also least injure the physical health, are gradually taking the place of those which most disregard the welfare of the body and the mind. I doubt very much whether the great change which has quietly taken place in this respect in our Boston schools, more especially in the last few years, including the addition of manual and industrial education and object teaching, is at all appreciated by the community, or fully understood by those who most criticise our public school system.

There is another much more important change which has been slowly going on for several generations, and more rapidly during the last quarter of a century, which should be taken into full consideration at the beginning of our inquiry into the question of the relation of our public schools to disorders of the nervous system, namely, a change in the mental and physical type of the race. For fifty years or more, the fact has been observed and remarked upon in this country, often in exaggerated terms, that the Anglo-American has become taller and thinner, with less appearance of robust physical health, with a more sensitive nervous organization, and with an increased intolerance of stimulants of all kinds.

At a recent meeting of the British Association for the Advancement of Science in Bristol, it was generally agreed by the large number of members of the associa-

tion who took part in the discussion, that a similar change was taking place in England, — that the John Bull of Nelson's time is not the Englishman of to-day. The same tendency has also been noted in Germany.

In a general way, it may be said that with some modifications due to climatic and social influences, this development of the nervous type of character bears a direct relation to the intellectual and industrial growth of the people. It is more marked in the United States than in Europe, and much more pronounced in Massachusetts than in any other part of our country. We see more of it, living in a land of such mental activity that twenty thousand patents are granted each year, in a state where there is a school to each three hundred of the population, and in a city whose public library is more consulted than the British Museum in London, a city of ten times the size of Boston.

The enormous increase in the popular knowledge of a few of the laws of health, the immense growth in wealth in all parts of the world, and the vast spread of the principles of humanity and philanthropy in dealing with those portions of society who are unable to protect and provide for themselves, have resulted in such an improvement in the sanitary conditions of our towns that the pestilential diseases are fast disappearing. There is, also, an immediate diminution in the mortality from all filth diseases, and a decrease in the average death-rate, with a proportionate saving of life.

Now those diseases which are chiefly affected when death-rates are lowered by a wise enforcement of the principles which lie at the foundation of an improved public health, are diarrhœal diseases and infection

diseases, which cause by far the greatest number of deaths in children under five years of age; typhoid fever from which about one-half of the deaths occur in or before early manhood and womanhood; and pulmonary consumption, a disease in which nearly forty per cent of the mortality falls upon persons between the ages of fifteen and thirty. But just as many people must die, and if more individuals live, by reason of our improved methods of living, beyond infancy and the early ages of life, just so many more will die of old age and the diseases peculiar to older people, and the death-rates will in time be equalized. That is to say, our efforts to improve the welfare of the human race have diminished the sources of death from one set of causes, and have proportionately increased them from another series of causes. If a person's chances of death from cholera infantum and typhoid fever are diminished, there is, of course, greater probability of his living to the full term of life until death by old age, but at the same time there are more chances of his becoming a nervous invalid, or dying with apoplexy. It is easy to see, therefore, that with fewer deaths from the plague, cholera, diarrhœal diseases, scarlet fever, typhoid fever, pulmonary consumption, there will also be a higher mortality from Bright's disease, apoplexy, paralysis, cancer, and those diseases of the brain and nervous system which are common to the later years of life. In other words, simply from our better habits of living, our increased cleanliness, our purer water supplies, our expensive sewerage systems, there has been an increase in the prevalence of diseases of the brain and nervous system independently of our schools, our factories, our libraries,

our churches, or entirely apart from those conditions and circumstances which are generally thought to give rise to nervous disorders.

The enormous growth of charity and philanthropy tends also in the same direction, by saving thousands of infant lives; our hospitals send out to renewed life and activity many who would otherwise have soon become helpless and died; improved medical skill builds up the weak and trains the imbecile, while an almost hot-house heat of the modern furnace rears the delicate children, which a century ago would have been virtually frozen out of existence in the barn-like rooms of our great-grandfathers, in which the tender lives struggled for existence. The survival of the fittest is brought about to some extent by a somewhat different process of selection from that which obtained a hundred years ago.

This has its advantages and its disadvantages. The pestilence that carried away its millions in a single epidemic not only took the weak and those unfit to survive, but it also, like the great fire consuming granite as well as pine, laid low the statesman and the great painter. The epidemic which killed its thousands of ill-favored, debilitated, and useless persons, hardly fit to live, also destroyed the most needed citizens. The inhumanity that let the children of the needy perish of neglect also failed to rescue, now and then, a genius or a great benefactor of mankind.

In redeeming the plague spots of our cities from the dangers of pestilential diseases, we have, at the same time, protected the more favored portions. But, on the other hand, we have by that very means reared many feeble and diseased individuals who otherwise would have per-

ished. For this, society gets its compensation in saving many persons whose brilliant minds make them invaluable to the world, in spite of their weak bodies, and in elevating its own moral standard. The fact is worth bearing in mind, though, that we thereby have more paralytics, more insane, and more persons of the neuropathic, or nervous, constitution, who react readily to external conditions unfavorable to health, and who easily became subject to the whole brood of nervous diseases.

I think that I am right, too, in saying that the prevailing type of nervous diseases has changed. The diseases of the imagination, which are cured by appeals to educated or uneducated superstition, by arousing the will, by stimulating the imagination, are disappearing, and are replaced by diseases dependent upon distinct disorders of brain nutrition, or indicating organic changes in the central nervous system. This circumstance shows both the high brain-tension of our age and the dangers of physical deterioration, two points of importance in our discussion of the school question.

The whole tendency of modern life is to physical strain and brain-worry, which are aggravated by a resort to all sorts of artificial stimulants; and, last of all bewildering devices, comes the telephone, to annihilate time and space. The very necessities of our civilization compel a high degree of activity and a high standard of accomplishment in some direction, with all the emotional strain of eager striving for success, or of repeated failure and disappointment. Our narrow streets and high buildings keep out the sunshine; our big cities devitalize the air, and bad sanitary arrangements in

most of our schools and houses make it still worse. The necessities of daily bread and butter drive children at an earlier age into occupations injurious to health.

In a recent number of the Boston Medical and Surgical Journal, there is quoted a lecture at the Parkes Museum of Hygiene in London, by Mr. James Cantlie, who says that it is impossible to find a pure Londoner of the third generation; that is to say, an individual whose two parents and four grandparents were all born and bred and continuously dwelt in London. It is rare to find an individual whose two parents and three out of four grandparents fulfil the above condition; and such an individual is a very miserable, ill-developed specimen of the human race, of stunted growth, low stature, small head, and feeble intellect, destitute of any faculty of enthusiasm or humor, and very liable to scrofulous disease. England, Mr. Cantlie tells us, is constantly pouring into London a stream of healthy folk, whose offspring degenerate, so that the race quickly ceases to be. The upper middle classes, the professional classes, who take a long annual holiday, and whose children are generally educated at public schools in the country, are, of course, to be excluded from this generalization.

A similar evil exists, more or less, in all great cities and large manufacturing towns, suggesting one of the most perplexing problems with which we have to deal, namely, the degeneration of the human race in crowded places, and what means we can take to counteract it. Do our schools help or hinder in this gigantic undertaking?

In the boys and girls of to-day we not only have a

more complex, delicate, sensitive organization to deal with, as compared with a century ago, but we have created a set of external conditions for them to live in, which is full of influences calculated to injure even a strong nervous constitution, much more a weak one.

That the difficulty of which I speak is a serious one, demanding our most earnest attention, no thoughtful person will deny. There are two ways of meeting it. The first will not find favor with any of us here. It consists in shielding the child or youth from every trial, and in carrying him over every hard place; in making everything easy for him, on the ground that he is not yet strong enough for the fight. The second foresees the struggles of life, and prepares the tender child, even, for them, by strengthening him in every possible way to meet and conquer them rather than evade them; at least, to carry life's successes with steadiness, or bear its reverses with equanimity.

The influence of our schools in producing this more nervous type of character, with an increased amount of diseases and disorders of the nervous system, and the present tendency of our methods of education in that regard, how far they add to the nervous debility or strengthen for the contests of life, are questions easy to ask, but, in my opinion, much less easy to answer. It is a problem which must be studied, not only in the class-room but also on the street, in the homes, at the theatre, in the dispensary-district, among the hospital out-patients, in the sick wards, behind the shop counters, among the factory looms. The question is often decided, I find, upon the evidence of a single case, or of two or three cases, and not seldom without sufficient

weight being given to all the possible explanations of the facts observed. For instance, a young man of twenty-two said that he graduated in his twelfth year, in a course of study usually finished at the age of sixteen, and that a few years later he became epileptic; that he had studied out of school more than the other boys, but that he got ahead of them chiefly by his brightness. Over-pressure in the schools has created epilepsy, was the immediate verdict. In the first place, are the facts as stated entirely correct? Secondly, if there was over-pressure in school, whose fault was it that it was allowed? did the teachers encourage or stimulate it? did the teachers protest against it, and the parents allow it? did the doctor advise against it, the teachers point out its unwisdom, and yet the parents insist upon a homicidal course, as happens sometimes? Was the case an illustration of that marvellous compensation in nature for failure in one direction by concentration of force in another, of which the epileptics Cæsar and Napoleon were the most conspicuous examples, or, finally, did the epilepsy arise from an accident, by a blow on the head, by a fall, or by a severe mental shock, — in conditions subsequent to the school-life or independent of it, an explanation rendered quite probable by the fact that an older brother did the same as the younger in school and is quite well. I am still seeking for the correct answer to these questions, without any expectation of ever finding it.

To take another illustration, a young graduate of a high school and of a college for women breaks down with all the symptoms of the familiar name "nervous prostration," and is passed about from one doctor to

another as an interesting example of the pernicious results of the higher education of women. Another physician sees her and thinks that he recognizes a certain physiognomy of disease with which he is familiar. After a study of the family history, as well as of the individual, he believes that there has been simply the evolution of a natural law of development in the case, and that a vicious constitution or a brain not entirely right at the start has not only not been injured by the mental training, but that it has been improved (and might have been improved more), that the breakdown is less disastrous than it would have been but for the schools and college. One set of doctors concludes that women have too much of study; another thinks that they have not enough or at least not of the right kind. Who shall decide? There certainly are not statistics available to settle the matter, if they ever can be got, and then there would come the inquiry, how were the statistics prepared?

The literature of the subject is abundant, but much of it bears the marks of hasty generalization or of prejudging the case. I will mention one recent report of this character, which has had great influence in London, because of the wide reputation of the author in another field of knowledge, but where the opinions advanced were confessedly formed before investigation, and where a statistical table of the prevalence of headache was soberly prepared and offered as scientific evidence, by asking those children to raise their hands who had headache in certain described localities.

As regards the influence of our schools on the health of the community, as shown by an increased prevalence

of disorders of the nervous system, the question presents itself to me in two different aspects: first, as affecting persons attending school; and secondly, in the effect of the school-training as manifested in later life.

At the outset, it should be said that there are schools and schools, and that there are teachers and teachers. Even in Massachusetts, a State which seems to me, in respect of its schools, to be living on its past laurels, schools may be found in commendation of which I could have very little to say. There are others for which I should suggest hardly a single criticism. The fresh air, broad sunshine, and simple habits of country towns may compensate for much that is bad in methods and amount of study. The constant hurry and excitement of a crowded metropolis may render the adoption of the wisest system of education a matter of the greatest difficulty. It is utterly beyond the power of the most accomplished superintendent, the ablest and most painstaking supervisors, the most conscientious teachers, to devise and carry out any plan of instruction which will wholly counteract the bad influence of conditions acting constantly and unfavorably upon the physical health of the pupils. The subject is a large one, and I shall endeavor to stimulate thought and effort, rather than to solve a problem. What I shall have to say will apply to Boston schools, because my time for this discussion is limited, and because I have less exact information about other schools. It is offered simply for what it is worth, as the result of the observations and experience of one man.

The task of the schools is no easy one. They must furnish a course of instruction flexible enough, not only

to suit the brilliant, the clever, those of average or fair ability, and the dull or even stupid, but also to be adapted to the sound and the unsound, the well and the ill. Different grades of mental capacity may be readily accommodated by advancing certain pupils and putting back others. Different standards of soundness or health can be provided for at best only imperfectly except with the coöperation of parents.

Among the conditions of departure from health, which one sees in the schools, the most important is the neuropathic, or nervous, constitution, existing in all degrees of intensity. In its pronounced form, it is closely allied to the well-marked functional diseases of the nervous system, and, at the critical periods of life, may readily develop into them. It is congenital, or due to early interference with the normal development of the brain by injury or disease, and it may be enormously aggravated from faulty training and bad habits of life. It shows itself in infancy and childhood by irregular or disturbed sleep, irritability, apprehension, strange ideas, great sensitiveness to external impressions, disagreeable dreams and visions, romancing, intense feeling, periodic headache, muscular twitchings,—conditions all of which, in my experience, have been attributed to the schools. There is often excessive shyness or bravado, introspection and self-consciousness. The imitative and imaginative faculties may be quick. The affections and emotions are strong. The natural feelings easily become disturbed and perverted. The passions are unduly a force in the character which is commonly said to lack will-power.

Self-discipline and self-control are acquired only with

great difficulty. The memory is now and then phenomenal. There is a ready reaction to external circumstances, even to the weather, by which the individual becomes easily a little exhilarated or somewhat depressed. They are apt to be egotistic, suspicious, and morbidly conscientious. Slight physical ailments, hardly noticed or rapidly recovered from in sound children, leave on them a long or lasting impression. They become neurasthenic, hypochondriacal, or nervous invalids, so called, and they break rules or disregard established customs with less cause or provocation than other persons. They lack stability, or have narrowed limitations of intellectual energy, in quality or quantity.

To the nervous temperament belong social and intellectual gifts and graces, originality, intensity, poetry, art, philanthropy, without which we should be great losers. Within reasonable limits, the nervous temperament, if fairly well trained, is a great benefit to society and the world. Of its extreme development we have the most conspicuous examples in our great cities. We see many such children in our schools, and we must provide for them in the best manner possible. They need not only as much care as other children, but far more, as lack of proper training results more disastrously to them than to others.

Next in importance come those children who have inherited weak bodies, or who have acquired physical weakness as a result of illness or injury; those who are sent back to school—a very common fault—before the strength has been fairly regained after infectious and other diseases; and finally, the large number who

suffer from disabling maladies of too obscure a character, or of too light a degree of severity, to be detected by the teacher or parent. Chorea, commonly called St. Vitus's dance, to mention a striking instance, is a general disease, associated with cerebral symptoms that are often overlooked, and with muscular twitchings which are unmistakable. It frequently occurs with sleeplessness, irritability, headache, inability to apply the mind, and slight loss of flesh, as the only noticeable symptoms. Sometimes the mother observes a simple change of character, that the youth becomes childish, the child babyish. In this stage or degree the case is quite likely to be thought one for discipline, whereas rest and medical treatment are indicated. Not seldom the parent, oftener the father than the mother, speaks of the idleness, stupidity, peevishness, obstinacy, untruthfulness, want of aptitude and receptivity of a child — terms which to them have only a mental or a moral bearing, while the physician sees that they depend upon conditions of disease which have no ethical signification whatever.

In the city of Brussels — the only place, beside Paris, where there is thorough medical inspection of schools — it is claimed that by that means this large class of children receive proper care, and it is asserted that the same results cannot be got in any other way. Some of them must be taken from school altogether; others should remain in school only a part of the school hours, or do nothing some of the time, if it is best for them to stay in school to keep out of the street, and many get on by dropping some incompatible or embarrassing branch or branches of study. The careful

oversight of many of our Boston teachers partly reaches this evil. It cannot be better illustrated than by reading a letter from one of them to a parent who, up to that time, had not observed anything wrong about her child. This girl came to the City Hospital a well-marked example of the neuropathic constitution, and at the time referred to had the mild form of chorea, for which she needed at least six months' careful attention to her health.

The letter is as follows: —

DEAR MRS. ———:

I am very sorry Mary is far from well. She was nervous enough before she was sick with her cold, but now she is so much worse. I think the best thing for Mary will be to leave school for a while and play out of doors. Keep her in the sunshine all you possibly can, and let her go out every day, no matter what the weather is. The close confinement of the school-room is very bad for any one so nervous. She was such a smart girl I am very sorry to have this happen. It is solely on her account that I recommend this measure, but I think you will find it will be for the best for her to drop all books for a while, and not study at all.

You need not fear but what she will know enough and learn enough by and by.

Perhaps if she could go away for a few days the change of air might help her.

Of course you must do as you think best.

Yours respectfully,

——— ———

Parents often bring their children to the hospital with just this sort of a statement, showing how careful of their pupil's health some of the teachers must be, to detect evidences of disease before even the mother's watchful eye sees them.

The children of the well-marked neuropathic constitution not only cannot live at the high pressure common to our age, nor even at a moderate pressure, but everything must be arranged for them on a low pressure scale. They are capable of only a limited amount of work, and easily break down if that limit is exceeded. It is simply impossible for them to go through the full routine of school work, and many of them, for that reason, drop out of the primary or grammar schools, without attempting the strain of the high schools; and yet they need such training as they are capable of even more than other children.

This class of children, of all degrees of mental and physical limitations, together with those who are ill or not sufficiently recovered from acute diseases, we will pass over for the present, and consider the influence of the schools on children and youths of fair physical health and moderate mental brightness.

It is not necessary, before this audience, to argue the value of physical health. If Mr. Mill insists that the man who aspires to be a teacher of his fellowmen must suffer from ill health, we simply answer that Mr. Mill would have taught more healthy doctrine, would have done more good, if he had not suffered so much from the headache and neuralgia and dyspepsia of overwork. Huxley's view is sounder, — that the successful men in life, in the long run, are those who have stored up such physical health in youth that they can, in an emergency, work sixteen hours a day without suffering from it.

Do the children of the public schools come up to a reasonable standard of health? — I do not mean the high standard of Huxley. I think that they are far

below it. Pale faces, languid work, poor appetite, disturbed sleep, headache, and what is vaguely called nervousness, are more common among them than they should be among children of their ages. I doubt whether there is an exaggerated prevalence of manifest or well-marked diseases of the nervous system among them. If due to the school drill, my impression is that they come for the most part later in life, after the children have left school, and because of constitutions weakened during the school years, instead of strengthened, as they should be. The causes of this serious evil lie partly in matters which can be, and should be, corrected in the schools, but fully as much, if not more, in conditions for which the home and the parents are responsible.

The definite defects or evils in our school system seem to me chiefly due to, first, over-pressure beyond the age or strength of the pupil; secondly, to bad air; and thirdly, to lack of physical exercise. In the first place, as to the age and hours of study of the pupils. There should be none admitted under the age of five. Of course, that is not a prevalent fault in Boston, as there are only half a hundred so young, out of a total of 52,000 of all ages, in that city. There are seven or eight thousand, a varying number, under the age of seven. For these children five hours' school work a day, even with the two hours' interval for dinner, seems to me altogether too much. From the age of seven to thirteen, I think that there should be no study outside of school, except possibly a review of some of the day's work for the children from ten to thirteen years old; and, after that age, not more, as a rule, than an hour of home study until the end of the high school or Latin

school course. Naturally, some youths cannot do so much as that; a certain number can do more with safety. I am aware that many of the teachers, perhaps most of them, or nearly all of them, endeavor to correct the tendency of conscientious pupils to study too much at home; but that does not entirely meet the difficulty, which can only be done by placing definite limits of age and hours of study for the various classes. In the primary schools, and in the lower three classes of the grammar schools, where there is supposed to be no home study, and the teaching is so largely independent of books, naturally only a limitation of school hours is needed according to age, provided the present rule not to study at home is obeyed. Of course, if children begin full study in the schools at an age so early as to do harm from over-pressure, the evil not only lasts through the whole school life, but it is cumulative, and is sure to more or less affect them as long as they live.

Competitive examinations for prizes or rank, the privilege of skipping classes by rapid promotion, and the rehearsals for annual festivals, have seemed to me in some cases to have done harm. Perhaps it will be possible to so regulate them as to retain the incentive for good work and not put too heavy a strain on children of sensitive and active minds. Single promotions are dangerous enough, and, I think, should be allowed only with the exercise of greater care than is common now. But what have I to express for double and triple promotions, for allowing an ambitious girl to skip at one leap two, even three, classes? Nothing but unqualified disapproval.

The fact is too often overlooked that intellectual

brightness in children may be only a symptom of illness. At all events, excitable, prococious children are not infrequently stimulated to overwork, when their proper place is in the doctor's hands.

Next to beginning school work at too early an age, by far the greatest direct evil, or sin of commission, in our schools, is bad air, especially where the school-rooms are over-crowded, as many of the primary schools are. Its influence in spreading infectious diseases is not to be overlooked, but it is ten times more injurious to the nervous system, from undermining the constitution by a slow poison. It causes headache, weariness, impaired appetite, enfeebled digestion, fretfulness, irritability, with a whole train of evils, for which over-pressure in study is falsely accused. At the same time that this evil is remedied, means should be taken to avoid the inequality of temperature, especially in the larger school buildings, which is, for the most part, a matter of coal and care. In the summer time, it seems to me that the schools should always be dismissed when the temperature exceeds 82° Fahr. I know that pure air in large, crowded buildings is costly, and I suppose that proper ventilation in our schools would involve an additional annual expense of, perhaps, ten or twenty thousand dollars; but the outlay would be more than repaid, and for the present condition there is not a shadow of excuse.

Among the home influences acting unfavorably, absence of sunlight in narrow streets, impure air, and insufficient diet are in some cases, and to a certain extent, unavoidable. An unwise diet, or injudiciously selected, is more common, even among those who can afford for their children an abundantly nutritious fare.

A great part of the harm from bad ventilation is loss of appetite, for which the child craves stimulants, and the parent yields to the wish for tea and coffee, which only enormously aggravate the evil. I rarely see at the hospital a child from the public schools whose health has not been injured by these stimulants, and then comes again the complaint of over-pressure. Cigarettes are a source of harm chiefly in the private schools, but sometimes in the public schools also.

In the high schools, the pupils are at an age when abundant and nutritious food is needed at intervals of not more than four or five hours. How often do we hear carelessness or inattention in this respect excused by the parent or teacher, on the ground that the child is not working, only going to school, and so not in need of a full diet; whereas the fact is just the opposite, that brain-work is the most exhausting kind of work, to meet the demands of which the brain should be thoroughly well nourished by abundant, nutritious food. The long sessions and the great distance of the schools from the homes prevent sufficient nourishment for many of the nearly two thousand pupils in the high and Latin schools, and again there arises impaired health for which over-pressure is the assigned cause.

Toward the latter part of the grammar school life, and during the high and Latin school period, the tired backs and heads needing fresh air and exercise get still more tired from sitting at the piano; outside duties and pleasures are allowed to overweary, more especially the girls, or to break in upon the hours of sleep, and this oftener does harm in my opinion than over-study; at least, social cares, and dissipations, and accomplish-

ments, cannot be safely combined with full school duty to any great extent; one or the other must be curtailed. The strain comes, too, at a time of active physiological development, when especial care should be taken that there should be abundant rest and sleep, with plenty of nutritious food and healthy out-door life. I have seen enough to convince me that want of proper care at this time does much harm, particularly in girls, that never can be fully remedied in later life; and yet the too ready resort to the bed or the lounge for slight ailments in girls and women seems to me to be creating invalidism, the blame of which is often laid to over-pressure or to inherent weakness of the female sex. The boys play and romp and have their military drill, but the girls have not the opportunity for that vigorous physical exercise which they need fully as much as the boys. Being more sensitive and emotional by nature, we deliberately bring them up so as to exaggerate these qualities and make them less strong and less self-dependent in later life. By the last record there were six thousand two hundred and twelve girls thirteen years old and over in our Boston public schools. Most of them who are in good health are better for continuous work; many who are subject to occasional disturbances would do best to disregard them to a certain extent, but a large number cannot do so with safety. One high school teacher in the western part of Massachusetts states that the girls in his school are excused from work simply at their request, and that, speaking from general impressions, he should say that they are absent from school one-tenth of the time. I doubt whether accurately kept statistics would fully bear out his statement

as to the amount of absence from school of the girls. If the fact is as reported, I am confident that harm is done as well as good, but that more care is needed in this respect than is common, I am quite sure.

If there is any defect or imperfection in the eyes, or ears, or lungs, or heart, or anywhere, as is not unfrequently the case, there is almost always a sensitiveness of the nervous organization, and a diminished capacity for work which renders especial care quite important. With an imperfect eye, the brain works harder to secure perfect vision. It is just the same with any other imperfect organ in performing its proper function, and hence undue weariness. These anatomical or physiological defects are so common, particularly in the eye, and they so often lie at the bottom of impaired health and nervous disorders, that it would be well for all parents to know whether their children are free from them, certainly before they are put to the strain of the higher courses of study, involving prolonged and concentrated mental effort, and preferably before the grammar school age.

The two diseases of the nervous system most commonly attributed to the schools are chorea or Saint Vitus's dance and epilepsy. I have never yet, however, seen one case of either disease, the causes of which did not seem to me to lie more probably in accidents or injuries to the brain, or, at least partly, in circumstances and conditions outside of the schools. I do not mean to say, however, that there are not schools which may be blamed even to this extent. It would not surprise me, if, on a careful search, several such were found.

When our first secretary of the State Board of Edu-

cation made such vast improvements in our public schools, he got many of his best ideas from Germany; and if we should go to Germany now, we should find that the Germans are just as far ahead of us at the present time as they were then, and in this respect chiefly, that, in their best schools, a system begun and most thoroughly carried out in Frankfort and Berlin, all the pupils are trained just as regularly and just as carefully in gymnastics, in physical exercise, both girls and boys, as in arithmetic and geography. This is a thousand times better than all the rest cures, and mind cures, and everything of the sort.

There is one immense influence of our public schools which I have been surprised to find quite generally ignored, namely, its great power in training the mind and developing character. It teaches self-respect and self-control, and furnishes internal resources for the struggles of after life, which seem to me one of the chief safeguards of society. Hard work is needed by nearly all of us. There are few persons who are not compelled, at some time in their life, to learn the necessity of not only doing disagreeable things, but of doing them easily, and home discipline is apt to be too defective in these points. If it were not for the public school training, thousands of children would grow up like weeds or Topsies, their fathers and mothers being too busy inculcating the filial duties to remember the obligations of parents to their children.

There is, without doubt, overstudy at home in some cases, and harmful overstudy, and there can be no system devised which will make it impossible. The amount of study which may be given to the lessons in

any but the lower grades in the schools is practically without limit, if the student aims for perfect marks or is interested to go to the bottom of the subject, and then he simply exhausts himself. If this is done, it is not necessarily the fault of the schools, but oftener of the individual for persisting in overwork, or of the parent for encouraging or allowing it. All that the teacher can do, given a not excessive course of study, is to advise and warn, which certainly is freely done in some, at least, of the Boston schools.

With regard to the diseases and disorders of the nervous system in adults, attributable to the schools, I have seen enough to convince me that many constitutions are impaired in the schools, and chiefly from causes which I have already pointed out. I think, however, that at least three-fourths of the causes of nervous exhaustion and nervous disorders generally lie outside of the schools, in natural physical disabilities, in unwise methods of living, especially in breathing too little fresh air, in neglect of physical exercise, in not heeding early symptoms of disease, too often in the resort to the habitual use of stimulants and narcotics, including the excessive use of tea, coffee and tobacco, those curses of nervous people. The functional diseases and disorders which make life wretched, without killing, are at least four times as common among women as among men, and the, to me, foolish conclusion is drawn from that fact that women are unfit for hard work, and responsible duties, and severe mental training. On the contrary, they are driven by their few resources to those branches of industry involving the most worry, the worst air, the least pay, and the great-

est anxiety, and they are denied the opportunity of that vigorous physical exercise and sound mental discipline without which men know perfectly well that they would be neuralgic, dyspeptic and suffering from all that is implied in the expressive word "nerves." Physical defects and imperfections are more trying to women than to men, and more is demanded of them in the way of maintaining a respectable appearance and living. What they need most is more, rather than less training; perhaps in some respects better training of the kind such as the public schools give, more colleges for women, more physical exercise, more knowledge how to take care of themselves, more opportunities in every direction. If women had all these, we should soon hear and see much less of the so-called nervous prostration and of the evil effects of over-pressure. Wear and tear in their work is greater than in men's work, and they need that higher education which is fast teaching the few to whom it is accessible how to live and keep their health. The colleges for women already established, as I read the evidence, have shown conclusively that the firmer mental balance which women get thereby is already telling in improved physical health. We do not see the graduates of them working all day, studying in the horse cars, snatching out a book between the acts at the theatre, and reading until midnight, kept up by tea, in order to converse intelligently about the last novel. In face of the many obstacles against which women in general have to contend, they must work harder, with greater worry and with more disappointments than men. There are more conditions necessary to avoid failures in women. Of course they break down earlier and oftener than men.

The physician sees constantly most lamentable breakdowns in young men and in young women who are struggling, against great difficulties, for an education — probably more, in proportion to the whole number, among young women than among young men, because the young women are in a field of effort which has not yet entirely passed the experimental stage, and they are still learning how much they can do and in what way they can best do it. In denying themselves sufficient recreation, fresh air, physical exercise, rest, sleep, food, in working late at night for the money to pay a debt, buy a coveted book, or provide the daily dinner, in failure to recognize physical limitations of health and strength, in the hurry to do five years' work in four or three years, in the wear and worry of outside anxieties, they often deliberately, often ignorantly, run great risks, as a result of which there must be a certain proportion of ruined health. Of a hundred brains strained to the average limit of tension many must break, but the fault, or the mistake, is, for the most part, with the individual.

In the present stage of the question of the higher education of women, while originality of thought, independence of social prejudices, activity and receptivity of mind, rather than soundness and stability of constitution, must characterize the young people who take it up, it is quite natural that the nervous or neuropathic temperament should predominate among them; that there should be many of unstable equilibrium, of sensitive physical organization, who break down easily whether they study or not. My own opinion is that even for these — I would rather say especially for these

— the higher education is a conservative, rather than a destructive, force. But they must learn that they need, in their management of themselves, more care and more self-control than others.

By the last census there were, within the ages of active work, from sixteen to fifty inclusive, in the state of Massachusetts, 52,483 more women than men. 6,413 of them taught school, as compared with 923 men, so that the question has already become a practical one. After the great Boston fire, fifteen years ago, it was perfectly pitiful to see how few useful and remunerative things the young women thrown out of employment could do.

I shall naturally be asked what can be done so far as our public schools are concerned? I am not one of those optimists who think that a legislative enactment or a commission or a board with a chairman and a secretary can relieve all the difficulties of the world. I am quite sure that skilled and experienced medical opinion ought to be more brought to bear upon these questions than it now is; but that would involve a great deal of time and much discussion.

What is there which can be done at once? In the first place, as I have already intimated, vastly greater injury is done to the nervous organizations of children at home than in the schools, and the greatest part of this comes from ignorance. The readiness of mothers to carry out sensible advice regarding their children's health convinces me that much can be done by systematic attempts to instruct them.

In the second place, the air of the schools should be made better at whatever cost.

Thirdly, means of physical exercise should be provided for all weathers, especially for the girls, who have not now even the defective advantages possessed by the boys in that respect, and as regular hours should be devoted to gymnastics as to mental training.

Fourthly, regarding the teachers. Under the improved methods of instruction, with fewer text-books for their pupils to memorize, the work is much harder for them than before. The slow poison which the children breathe in for a few years from the badly ventilated class-rooms, at a time of life when there is naturally a superabundance of the tendency to healthy processes, and a great power of throwing off all sorts of injurious influences, the teachers must breathe, year in and year out, at a time of life when they have little superfluous strength, and, if anything, are almost daily overtaxing what they have. The tenure of their positions should be as free from worry as is compatible with good service, and they should, like the professors at Cambridge, have a year's furlough at stated intervals, without losing their places.

On these four points, I think that there can be no real difference of opinion among competent and thoughtful persons who have given the subject sufficient attention.

With regard to the hours of study for children of different ages, I am aware that there will be a wide divergence of views among those who have carefully considered the matter. I can only repeat my own conviction that full school hours are begun at too early an age in the Boston public schools, and that only evil can come of it. I believe, too, just as strongly, that the fact has been

demonstrated that children under fourteen years of age cannot bear much, if any, more than an hour's continuous study profitably, perhaps not without harm, and that for them each hour's brain-work should be followed by ten or fifteen minutes in the open air in fair weather, and exercise or recreation in all weathers. This is accomplished to a certain extent and for pleasant days by our recesses, but I am informed that a suggestion is made, which I earnestly hope is not the case, to abolish those very useful breathing spaces.

For children of fair strength and average ability, living under reasonable conditions of health, in the school and out of the school, is the present course of study in our public schools in Boston one to cause over-pressure and disorders of the nervous system, provided the pupils begin at the age of seven, or do half-time study from six up to that age, with few hours and little but object lessons from five to six?

My very decided opinion is that there is harmful over-pressure, and that there is room for further improvements in the direction in which I have intimated that so much has already been admirably done of late years. I am quite sure that bright children are promoted too rapidly, and that the number of studies can profitably be diminished for nearly each day's calendar, in the upper classes of the grammar schools and in the high and Latin schools.

I will repeat my opinion already stated, that the greater part of the ill-health commonly attributed to the schools arises in conditions for which the responsibility belongs to the home and to the parents, perhaps in a certain degree to social customs and to society at large.

The correction of this difficulty is no easy matter. In some cases it is beyond the parents' power to do otherwise than they are doing; foolish subserviency to what they consider fashion controls many more, and the work of educating others up to a full sense of their obligations to their children, and to a knowledge how to do what is best for them, is one requiring time and patience.

The greatest difficulty will be found in attempts to adjust the school work to different degrees of health and strength, especially to the different manifestations of the nervous constitution. How far this should be done by the parents, how far by the school authorities, at what age different children should be allowed to go to school, how far the school course should be modified to suit their capacity, who shall decide what studies shall be dropped, and when certain pupils shall leave school for a while, — in a word, to what extent the training of fifty thousand children shall be individualized, — these are all most important and interesting questions which must be met in a variety of ways.

Whether or not the schools are adding to the total amount of nervous instability, and disease or disorder of the nervous system in the community; whether or not the confessed injury done by the schools is counterbalanced, or more than counterbalanced by the enormous good which they do, one fact is beyond question, namely, that the schools do not do all they can, and ought, to counteract the tendency of the age to all sorts of physical ills arising from the high-pressure rate of living, the high social tension which we see everywhere. Can we afford, simply as a matter of social and political economy, to allow them to do any less than their

utmost in this respect, when we consider that at any given time one-eighth of the population of the city is in the public schools, and that there are comparatively few others who at some time have not been, or will not be, under their care?

In the city of Brussels each school is visited weekly by a trained medical inspector, who examines the school-rooms for suggestions regarding improvement in construction, ventilation, heating, etc. He looks after the condition of the air, drains, and all matters affecting the health of the pupils. He sees that the temperature of the rooms has been recorded four times a day, and he compares for himself the temperature at different places, — near the floor, on a level with the pupils' heads, and toward the ceiling. He prescribes the various means and methods of exercise, including the out-door gymnastics; directs the walks, excursions, and instruction in swimming, carefully looking over each child to see whether he or she is strong enough for the full school routine in these respects as well as in the matter of studies. If, in summer, the temperature exceeds 28° C. or 82.4° Fahr., he dismisses the school, and may order pleasant walks in place of the regular school duties. He is to superintend the physical development of the pupils, and to advise against too fatiguing methods or courses of study. He keeps records, taken at regular intervals, of the height, weight, general condition, etc. of each pupil, which constitute a sort of life history, to be carried home and kept by each one upon leaving school. He instructs the teacher how to recognize infection-diseases in their early stages, and sees that the regulations regarding them are enforced.

He devotes especial care to the weak and sickly children, to see that they get the best possible result from the school training, supplying to them medicines, chiefly tonics, free of cost. Children under fourteen years of age, after each three-quarters of an hour's study, have fifteen minutes for recreation, which must be in the open air, when the weather allows it, and this the medical inspector regulates. The physical examinations of the pupils include particularly the eyes, any defects in which are corrected, so far as is possible ; and the dentist for the schools treats, on an average, about ten pupils each school day.

In Frankfort-on-the-Main there have been buildings for gymnastic exercises connected with the public schools, but entirely separate from them, and supported by the public, for more than thirty years. There are eighteen such in the city, beside a number of large halls for gymnastics in school-buildings and out-of-door grounds, arranged with the usual appliances of a gymnasium. There are more than a hundred teachers of physical exercises. The children are also taught swimming, and take numerous walks and excursions, under the guidance of teachers, for pleasure and instruction. There is not the same systematic medical inspection as in Brussels, but the pupils are examined by physicians, as required, to guard against infection-diseases, and to provide lowered standards of work, in studies and in physical exercises, for those who are not sound in mind or in body, as the case may be. Each hour's study is followed by several minute's recreation, out of doors if the weather permits. Once a year the pupils of the public schools have a day's excursion into the country,

and shorter pleasure trips are also made, from time to time, usually Saturdays.

In the long summer vacation, nearly two hundred feeble pupils are selected for a month's visit among the hills and fields — this, however, is at private cost, by subscription, and is under the direction of persons competent to look after the boys and girls, and to instruct them in general deportment, diet, and the laws of health.

The Germans and the Belgians tell us not only that they are satisfied with the results, but that they are demanding from the authorities further advances in the same direction; that they spend more money on their schools, but believe that they shall thereby lessen the expenditure for prisons and poorhouses and hospitals and jails.

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DRAINAGE.

EPIDEMICS AND DISINFECTION.

EYES OF SCHOOL CHILDREN.

THE RELATION OF OUR PUBLIC SCHOOLS TO THE DISORDERS OF THE NERVOUS SYSTEM.

SCHOOL HYGIENE.

VENTILATION AND WARMING.

Press of
Berwick & Smith,
Boston.

The Foundation of Death.

A Study of the Drink Question. By AXEL GUSTAFSON. American Copyright Edition. 629 pp. 12mo. Cloth. Mailing price, $2.00; Introduction price, $1.60.

As may be learned from the subjoined notices, this book has already been accepted in England as the most complete work on the subject ever published, and one that will be "the Bible of temperance reformers for years to come." It is pronounced the fairest, most exhaustive, freshest, and most original of all the literature on the subject that has yet appeared. It is impartial and careful in its evidence, fair and fearless in its conclusions, and its accuracy is vouched for by the best physiologists and physicians.

The book was not made to prove a theory, but was the outgrowth of a pure and unprejudiced seeking after the truth. The drinking habits of the English people, as they were illustrated in the streets and homes of London, first led the author to examine the drink question, and "The Foundation of Death" is the outcome of his researches.

In preparation for this work, the author has made exhaustive and impartial researches in the alcohol literature of nearly all countries, having examined, in the various languages, some three thousand works on alcohol and cognate subjects, from a large proportion of which carefully selected quotations are made.

It contains a bibliography of over 2000 works, arranged chronologically, and the works of each country separately. As far as has been possible, all departments of this study have been brought up to date.

The scope of the work, as to the variety of standpoints from which it is treated, is indicated in the following list of chapters.

I. Drinking Among the Ancients.
II. The History of the Discovery of Distillation.
III. Preliminaries to the Study of Modern Drinking.
IV. Adulteration.
V. Physiological Results; or, the Effects of Alcohol on the Physical Organs and Functions.
VI. Pathological Results; or, Diseases caused by Alcohol.
VII. Moral Results.

VIII. Heredity; or, the Curse entailed on Descendants by Alcohol.
IX. Therapeutics; or, Alcohol as a Medicine.
X. Social Results.
XI. The Origin and Causes of Alcoholism.
XII. Specious Reasonings concerning the Use of Alcohol.
XIII. What can be done.

Cardinal Manning: I have seen enough of it to say that I know of no other work so elaborate or so complete. The immense mass of miscellaneous knowledge contained in it can, so far as I know, be found nowhere else; and the arguments by which you prove the perilous and pernicious effects of intoxicating drink, in all its forms, are, in my judgment, irresistible.
(*Aug.* 13, 1884.)

W. S. Caine, M.P.: It is not possible to speak too strongly of its great value to the temperance movement. It should be in the library of every politician and social reformer. (*Aug.* 12, 1884.)

Canon Ellison, *Chairman of the C. E. T. S.:* I can conceive nothing better calculated to awaken enthusiasm in temperance reform where it does not yet exist, or to sustain it where it does. (*Aug.* 5, 1884.)

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(*Aug.* 5, 1884.)

Samuel Morley, M. P.: The more I have thought on the subject, the more convinced I am that the book will supply a want much felt.

Stopford A. Brooke: It has been done with sincere fidelity to the subject. In fact, it is just what is wanted, — a book eminently usable, which will supply in portable and admirable form the ground-work of lectures, addresses, etc.

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Dr. Norman Kerr: This great work will, I feel convinced, have a profound and permanent influence on the educated mind, and on the public opinion of America, Britain, and the continent of Europe.

Dr. Robert Laird Collier: It is an original and thorough treatment of the subject, and must become a permanent text-book in the literature of temperance. The book is as interesting as a novel, and as instructive as a treatise on science.

Hon. Neil Dow, *Portland Me.:* I have examined it with great satisfaction. It is an admirable work, and ought to be in the hands of everybody who takes an interest in the solution of the great problem. It is a resumé of all that concerns the relation of alcoholism to the individual and to society.
(*Sept.* 3, 1884.)

Dr. Daniel Dorchester, *Natick, Mass.:* I regard it as a volume of unusual value, and very timely. It will command close study and be of great

service to clergymen and other temperance workers, teachers of hygiene and temperance, and all who desire to understand the alcohol question. It comprises the latest scientific data bearing on the subject of alcohol. (*Sept.* 5, 1884.)

Dr. A. A. Miner, *Boston:* It appears to be a complete *thesaurus* of information on the drink problem. It is a work of extraordinary value. (*Sept.* 6, 1884.)

Rev. M. J. Savage, *Boston:* It seems to me a sort of distilled and concentrated library. It aims — and, so far as I am wise enough to judge, successfully — to sum up the whole case for and against the use of alcohol. It appears to me impartial, and to use strong language only when amply warranted by facts. I wish this work might become a text-book in the schools. (*Aug.* 29, 1884.)

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John G. Whittier: I have been reading with great interest and admiration Mr. Gustafson's masterly work. It is a treatise which entitles him to a high rank as a scholar and thinker, and to a place among the great benefactors of mankind. (*Dec.* 11, 1884.)

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